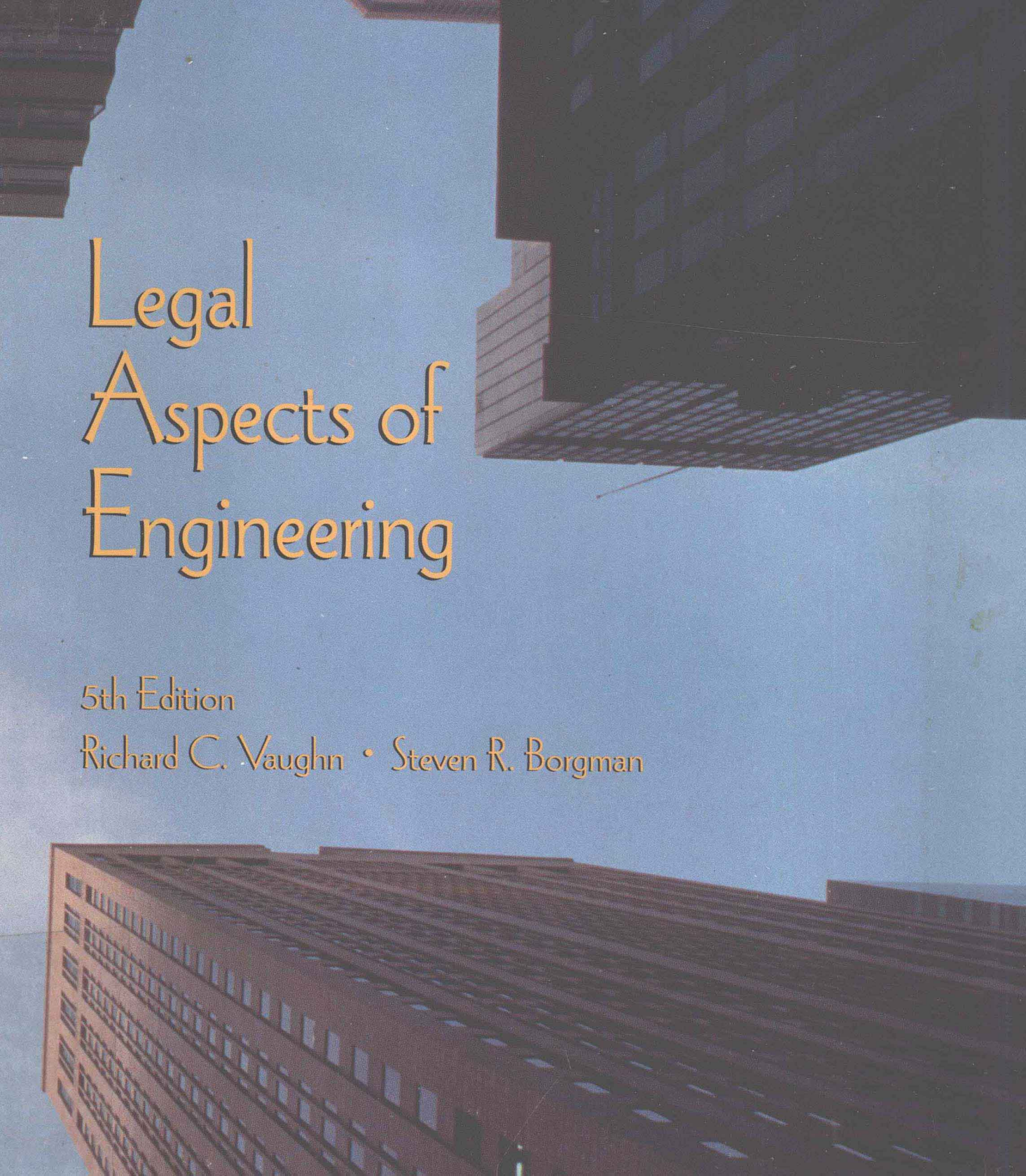
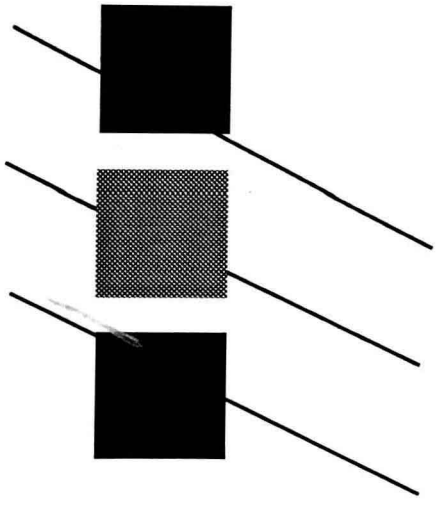


Legal Aspects of Engineering

5th Edition

Richard C. Vaughn • Steven R. Borgman



Legal Aspects of Engineering

Fifth Edition

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Preface

Legal Aspects of Engineering is intended to introduce engineers, architects, and others interested in engineering projects to pertinent legal concepts. It is not intended to replace the services of an attorney. Rather than replace those services, it should make them more useful to the legal client. If the services of a member of the bar are sought by an engineer who is aware of basic legal principles pertaining to the engineering activities, the contacts with the attorney can be expected to be more efficient and satisfactory. In addition, an engineer who has some knowledge of the law as well as engineering specialty is better prepared to act as an expert witness if the need arises.

Earlier editions of this text evolved from classroom notes to teach engineering classes. Changes and additions to this fifth edition come from two main sources. The first is commentary from users of the text. The second is the result of various cases handled by one of the authors. Based on this experience, the chapter on intellectual property (patents, trade secrets, and so on) was greatly expanded. Although many of the old cases are retained, many were replaced to reflect changes in technology and legal philosophy; and many of the chapters were substantially rewritten.

Law cases are presented at the end of most chapters. The cases serve to illustrate the principles and concepts in the chapters, but more importantly, each case also provides an example of legal reasoning. Because legal reasoning is somewhat different from engineering problem-solving logic, the cases have been preserved virtually intact. The only deletions are the case references; while such references are of interest to an attorney, they can tend to break an engineer's trend of thought as the case is read.

The authors are deeply indebted to many persons for their help and comments. Deep gratitude is owed to Verena Borgman, especially for her patience, tolerance, and encouragement. In addition, Robert and Nancy Borgman deserve thanks, again for patience, tolerance, and encouragement above and beyond the call.

R. C. Vaughn
S. R. Borgman

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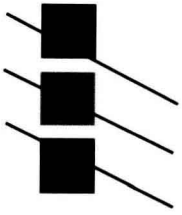
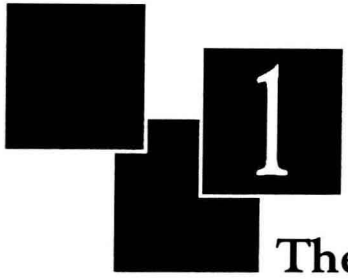


PART 1

Overview of Engineering and the Law

The first jobs most engineers hold after they receive their bachelor's degrees are in the employment of others. They become members of management teams. Many of them rise to higher positions of management, where they continue to use their engineering backgrounds even though their titles may imply only management responsibilities. Other engineers find that solving engineering problems is so exhilarating that they go on to solve such problems for others as consultants. Still other engineers pursue careers in the military, academia, and in federal, state, or local governments.

In any of these endeavors, the engineer's relationships with others are prescribed by rules of law and ethics. Such rules provide the respective rights and responsibilities of the parties. A knowledge of these rules, then, is valuable to the engineer. In this first part we study these rules as well as relationships and controversies that spring from them.



The Engineer in Management

Engineers are problem solvers. They possess unique tools for stating problems in such a manner that they can be solved and for providing solutions to such problems. Their expertise in stating and solving problems results from screening, natural selection, and specialized training in problem-solving techniques. It is this ability to state and solve problems that employers hope to find when they hire engineers, and it is because of the many uses for this knowledge that there is presently a substantial demand for engineering graduates.

Most training offered to engineers equips them to solve problems of a mathematical nature—problems that may readily be reduced to symbolic form. However, not all problems lend themselves to such an attack. The stress resulting from a given force applied to a particular design of beam is easily stated in mathematical terms. It is a little more difficult, but usually still possible, to assume probabilities and solve for the number of parts to be run or for warehouse space required for next year's production. It is exceedingly difficult, though, to formulate or state laws governing the relationships between people in terms of x's and y's with proper coefficients and thereby solve legal and ethical problems. Most such problems involve the interpretation of human laws and the use of discretion and judgment in determining rights and responsibilities.

Often, the solution of legal problems and problems involving human relations are no less important to a successful engineer than the solution of mathematical problems. In most engineering jobs, the engineer is part of a so-called management team. Before turning to the aspects of law with which engineers should be familiar, consider certain management skills they should strive to acquire.

ENGINEERING MANAGEMENT

For the vast majority of engineering graduates the first job secured is merely a stepping stone to higher positions. Most people, including engineers, are ambitious. It is only natural that engineering neophytes should raise their sights toward positions that offer greater rewards.

Normally entry-level engineering jobs require a large amount of technical skill. As they move up their career ladders, the percentage of time in which seasoned engineers use their technical skills usually

decreases. Regardless of the ladder the engineer has chosen to climb—research, manufacturing engineering, consulting, sales, or any other—progression to higher levels depends on at least four factors in addition to engineering ability.

Communication Skills

An idea initiated by an engineer may have very great latent value, but until it is used or communicated in some way, the idea is worthless to the engineer and to others. In addition, the very mental work necessary to develop the idea in a detailed description or a diagram is in itself of value. Nearly everyone has had the experience of gaining new insight or of discovering added features of an idea when faced with the task of trying to explain it to someone else.

Handling People

A promotion from a strictly technical position to one of greater responsibilities almost always leads to handling people. Being "boss" isn't easy. People can be forced to work under threat of being deprived of their paychecks, but such threats usually stifle initiative. The manager who takes time to explain to subordinates "why" and to keep them informed is likely to be more successful than one who does not.

Sense of Cost

Most operations are undertaken with a profit motive. Even in situations when operations that are not expected to make a profit (such as a service department), cost is usually important. If the selling price of a company's product is unchanged, money saved in manufacturing or raw material cost represents added profit; conversely, added cost decreases profit. Many engineers have won promotions and many consultants earn their livelihoods on their ability to analyze operations and reduce costs.

Knowledge of Law

Engineers are not expected to become attorneys from an exposure to one survey course in law, any more than attorneys could become engineers by taking one survey course in engineering. However, engineers should be cognizant of the probable effects of carelessness in dealing with others. Engineers should know when they need the advice of an attorney. The law background is a "preventive" asset; that is, with a basic knowledge of law, engineers should be equipped to prevent costly lawsuits against their company. Meticulous reading of contracts before signing is an important preventive measure. It is often surprising how little attention is paid to contracts and supporting documents, particularly in view of the fact that these documents outline the rights and responsibilities of the parties.

EXECUTIVE QUALITIES

In recent years there has been an increasing trend toward filling top management or executive positions with engineers. Companies have recognized the value of the engineer's analytical approach to executive problems.

Although there is a good deal of truth to the often quoted comment that "there is always room at the top," those who get there usually possess special abilities. Engineering training is beneficial to the executive aspirant, but so is a knowledge of many other fields.

What makes an executive? Why does one person achieve this goal while many others strive and fail? At first glance, the

behavior of one successful executive appears to have little in common with that of another who is equally successful. One may be the brusque bull-of-the-woods; another may be as smooth as silk. However, closer examination reveals certain similar behavior patterns. Each usually possesses the four qualities just mentioned for successful managers, often to a high degree. Other qualities, too, are seemingly common to most top executives and deserve consideration.

Leadership

The quality known as leadership is difficult to define. It is clearly evident in one person and strangely lacking in another. Psychologically, leadership indicates an identification of the group with the one who leads—it is necessary that the leader be considered by the group as one of them. It is also required that the leader be somewhat superior to the others in the group in one or more qualities esteemed by them.

It is doubtful that anyone is truly a "born leader." It is more probable that leadership qualities result from training acquired both consciously and subconsciously—study and observation so ingrained that the leader's responses to various situations are almost as natural as breathing. Thus, the term "born leader" has come to be used in reference to the leader who seems to do everything right at the right time in a very natural way. Leadership qualities seem to be enhanced by practice.

Opportunities to practice the poise and purposefulness of leadership occur in virtually limitless ways. One of the main reasons job application blanks nearly always contain space for listing organizational activities is to determine the amount of practice in leadership the candidate has had.

Two outstanding leadership characteristics are the ability to keep the ultimate goal uppermost in mind and the ability to pursue it enthusiastically. Enthusiasm is infectious—it rubs off on others. The relative success of dictators and would-be dictators attests to this. A speech delivered in a monotone makes for dull listening; however, the same speech using virtually the same words but delivered enthusiastically can move people to action.

A leader does not need a leaning post—either literally or figuratively. Leadership stems partly from the ability to stand firm on principles. There is a popular misconception that a leader should not admit mistakes. Few people make perfect decisions all the time, however. Not only must leaders admit their own mistakes; they must also take responsibility for the mistakes of their subordinates, because those actions result from the leaders' direction or lack thereof. Scapegoating is a popular art, but few effective leaders in top management will stoop to it to avoid criticism.

Delegating

A characteristic most top executives share is the facility for delegating authority and responsibility to others. It is virtually impossible for anyone to rise to the top of a modern industrial organization without the ability to delegate. There is just not time for one person to effectively and thoroughly perform the requirements of a top management job. Executives who delegate few tasks rob themselves of time needed for adequate thought before making decisions. Also, the failure to delegate routine tasks to others can be a barrier to executives' promotions; if no one can be found who has performed a portion of the executives' tasks with the

authority necessary for that performance, it is natural to leave the executives where they are.

Specialization is an inherent advantage of effective delegating. No one is a specialist in everything. By assigning some of their tasks to others, executives can obtain the advantage of specialized treatment.

Delegation as the term is used here (and in most businesses), means more than merely assigning tasks to be performed. Delegation includes clothing the delegee with the necessary authority to carry out the assigned function. It is this parting with a portion of authority that causes shortsighted executives—consciously or unconsciously—to oppose delegation to others. It is this very aspect of delegation, however, that contributes to the growth of assistants. The able executive realizes this and takes full advantage of it in helping others develop.

Decisions

All of us make decisions involving choices among alternatives. Our choices are not always correct. One attribute that seems characteristic of those people who reach top management is their ability to be right a higher percentage of the time than the average person. Of course, top management decisions are decisions about particularly difficult problems. Decisions run all the way from a single-variable problem (like checking a part with go/no-go gauge) to multivariable problems where little, if anything, is fixed or known. Generally, routine decisions are delegated to others; the top manager is the one who makes the decision when major uncertainties exist. People that make decisions such as these are venturers—people who will assume risks in their decisions. Generally, the greater the risk undertaken, the greater the possible reward. The decision to expand a plant or install new production facilities based on an apparently expanding market is such a decision. No one can predict the future—the further into the future the planning, the more inaccurate it is likely to be.

Top management decisions generally consist of five elements, dealt with in sequence:

1. a gathering of facts
2. a recognition of limiting conditions
3. assumption of facts and conditions as they are expected to be and recognition that these are assumptions
4. analysis of the facts, limits, and assumptions
5. decision

Many of the assumptions can be reduced to probabilities. If enough of this can be done, the problem can be programmed for a computer, which will then give the executive some answers. However, the answers are based on assumptions and probabilities, and the executive must decide whether to go ahead. The risk is still the executive's, not the computer's.

A few top executives possess such vast knowledge and the ability to analyze and synthesize that they can make rapid-fire policy decisions that are nearly always right. However, such people are rare. Generally, people in top management do not make hurried policy decisions. There is often grumbling from below because of apparently undue procrastination. Despite the grumbling, such delay is usually the course of wisdom, because the risks are frequently sizable. A decision based on inadequate facts or erroneous assumptions is hazardous, and delay in waiting for more facts is often inescapable. Even the rare

management genius who makes correct decisions rapidly usually has had many years of experience in more methodical decision making that has equipped him or her for this present role.

Discipline

Discipline is a necessary component of any well-run organization. People must be taught; old habit patterns must be changed. Most top executives are masters of the use of reward and punishment in changing the behavior of subordinates. To be effective, executive orders must imply some form of reproof for disobedience; rewards of some sort must follow outstanding performance if the effort required for the performance is to be continued.

The extent to which reward and punishment are necessary depends to a great degree on the personal stature of the executives. If they are held in high regard by their subordinates, a word or so of reproof is often the equivalent of the proverbial 10 lashes.

In addition to people's drive for food, water, and the means of satisfying other basic needs, they have a whole host of derived needs, not the least of which is the need of recognition. Every person needs recognition or respect from others—lack of it causes loss of self-respect and, eventually, diminished effort. Recognition can be either tangible or intangible, and both forms are required. Verbal praise sounds hollow after awhile if it is not accompanied by some material reward. Similarly, material rewards without praise for accomplishments are incomplete.

It has often been stated that rewards should be public, with criticism or punishment private. The truth in the statement is inescapable. Most top managers observe this principle in the interest of preserving their organizations.

These are only a few of the principles that guide top executives in their management of discipline. Most of these guidelines are understood and observed without conscious thought when disciplinary occasions rise.

Many qualities can make a person successful in top management. Only a few have been mentioned here. Nevertheless, these few are basic and must be mastered by executive aspirants. The purpose of a business and its management is to produce something. Converting time and raw material into goods and services requires production facilities. Assembly of the machines and equipment required to produce a product is normally undertaken as an engineering project. Not only must the original facilities be planned and built but every design change or functional change of the product also requires changing machines and equipment. The job of setting up production facilities becomes, then, not a "one-shot" enterprise, but an almost continuous replanning and rearrangement.

The burden of deciding when and how much to change—and what to change to—falls on top management; the job of planning and carrying out the details of rearrangement is usually assigned to the engineering department.

ENGINEERING PROJECTS

A large proportion of the capital wealth of our country has resulted from engineering projects. Civil engineering projects—roads, bridges, buildings and the like—are most familiar to the public. As a result, whenever the term *engineering project* is used, visions of a dam or expressway cloverleaf are likely to come to mind. The value of civil projects cannot be denied, but contributions by other engineering fields are also significant, even though the public is not as aware of these activities or results.

Since the development and adoption of mass-production methods in the United States, a new combination of engineering talents has taken place. People are needed who can apply knowledge of civil, mechanical, electrical, chemical, industrial, and other engineering fields to manufacturing problems. This combining of engineering talents to solve manufacturing problems has come to be known by many names, but the term *manufacturing engineering* seems more appropriate than most. Typically, manufacturing engineering is concerned with the process required to mass-produce some product. It starts with an analysis of someone's brain child and continues as long as there are engineering problems to be solved. The following discussion covers the various stages of an engineering project in a manufacturing engineering context. However, the same basic concepts apply to other types of engineering projects, too.

Manufacturing Engineering

Any engineering project involves three phases or stages of development: (1) conception of the idea, (2) reduction of the idea or practice, and (3) refinement of the idea and ensuring that the project works. The stages are fairly distinct, and a particular engineering group may have responsibilities in one or more of the stages.

Conception of the Idea

Just about every product and convenience we enjoy started as someone's idea or "screwball notion." Neither products nor the processes by which they are manufactured can be developed without someone's original idea. Not all ideas are practical, however. A large number of those that are adopted require substantial alterations before they are acceptable. Many ideas appear attractive in the beginning only to be demonstrated as impractical by objective examination. This objective examination of a possible engineering project is known as a *feasibility study*.

A feasibility study is a preliminary examination of a proposed idea. It is meant to answer such questions as: What will it cost to produce various quantities per year? Can we market enough to make a reasonable return on the required investment? How many can be sold at a given price? What processes will be better in the long run? The answers given determine whether it is desirable to proceed to the next stage—actually setting up to produce.

Reduction to Practice

Turning someone's idea into a reality can be quite complex in a manufacturing situation. Planning is necessary. The planning requires imagination—a vision of the future—and the planning continues until all the pieces are firmly in place. Even then, maintenance should be planned. Changes are made easily in the planning stage—it costs little to erase a machine location on a layout and place the machine in another location. Even rearrangements of the entire process are inexpensive at this point. It is here that questions pertaining to equipment sizes, locations, and added features must be answered and the answers justified if the process is to be successful. Layout changes after the process equipment has been placed are very expensive. For this reason, questions that should have been raised in the planning stage but were never brought up reflect on the process engineer's ability. A member of a manufacturing engineering department cannot be omniscient, but it helps.

The process engineer designs a layout of the process, complete with machines and equipment, and writes specifications for the machines to function as desired. The specifications are then sent out, proposals received, and contracts awarded to the successful bidders. Engineers are the owner's agents; as such they often must supervise the building of machines or other structures to fit the layout and then supervise the installation. Engineers also must control the times of completion of the elements of layout. Rarely is a process completed and functioning properly within the original timeframe. There is nearly always at least one contractor who is late. A wise engineer will allow some time for this in the schedule.

Refinement and Oversight

It is probably safe to state that in every manufacturing process ever installed there were special problems to be solved before full-scale production could begin. The presence of "bugs" in a newly installed process is about as normal as any expectancy can be. The bugs must be removed before the process can be considered complete. The engineer who set up the process is the logical person to remove these bugs before the operation is turned over to the production people.

LAW AND ENGINEERS

In any engineering project, engineers act as professionals; they are the representatives, or agents, of the owner. Their function is to act in the best interests of the owner—to get the best possible results with a minimum of delay and problems. Engineers must deal with the rights of others. Engineers' actions affect others' property rights and personal rights—rights they have due to ownership of property, contractual obligations, torts, or crimes. An engineer is a guardian of the owner's rights and, in a manner of speaking, of the rights of others with whom the owner deals. Because court proceedings are costly in both time and money, engineers generally should avoid entanglements that would lead to litigation. And, because violation of the rights of others is likely to lead to court proceedings, engineers must know the characteristics of these rights if their preventive job is to be well done.

The relationships between the owner and contractor are set forth in a series of documents drawn up by the engineer. Documents such as instructions for bidders, requests for proposals, proposal, general terms and conditions, specifications, drawings (and sometimes purchase orders, order acknowledgments, invoices, and the like) compose parts of the contract. Careless errors in the preparation of these documents can cause legal controversies or place the owner and engineers in indefensible positions when controversies arise. Engineers must formulate the documents in such a way that the owner's position is protected. Imposing an undue hardship on the contractor may lead to unnecessary litigation. Similarly, ambiguities in the terminology or leaving too much to future agreement can lead to unnecessary litigation. Hence, specificity and realistic goals are what the contract usually requires.

In some respects the engineers' position is between the owner and the contractor. When disputes arise, engineers are likely to be called on to mediate or at least enter into the controversies. To do a reasonable job in this position, engineers must be acquainted with the legal rights and responsibilities of both parties. Engineers don't have to be attorneys, but some knowledge of the law is essential. Engineers should be able to recognize situations in which it is necessary to consult an attorney. Some knowledge of the law is re-

quired even for this; you can't very easily recognize legal troubles unless you have some knowledge of the rights involved.

As with other human endeavors, obtaining expert advice as early as possible can avoid problems or serve to provide damage control. There is a second reason for engineers to acquire a knowledge of the law. Besides their professional activities, engineers are citizens as well. The law controls many of our private day-to-day dealings with others. When we buy insurance or sign a chattel mortgage for the purchase of a refrigerator, our rights and responsibilities should be clear to us. At the very least, the idea of reading the document before we sign it should occur to us.

Engineers are members of society as well as professionals who possess technical skills. As educated members of society and professional people, their knowledge and abilities should extend well beyond their technical skills. One popularly accepted criterion of the cultured person is the ability to analyze and discuss news events with some perception. Much of the news presented to us by radio, television, newspapers, and magazines has legal significance. If engineers are to be accepted and respected as learned people in their community, their interests and knowledge must be broad enough to justify this acceptance. An acquaintance with legal issues is a step in this direction.

REVIEW QUESTIONS

1. Why should an engineer have some knowledge of the law?
2. Name at least three more qualifications an engineer should possess for success in management. Name at least three additional qualities of successful executives.
3. What are the stages of an engineering project? What would each stage be composed of in the proposed manufacture of, say, tie clasps?
4. What is manufacturing engineering?

2 Ethics

Engineer are professionals; the occupation they have chosen is one of the newer professions. Until quite recently the only callings of sufficient dignity and dedication to public service to be termed professions were law, medicine, and theology. These three "learned professions" are still looked on by the public as the pinnacle of professions. Because of the intimate contact between members of these professions and the public, this view may never change.

Engineering has existed as a separate calling for about a century and a half. Considering the short span of its existence, the progress of engineering toward top professional standing is quite striking. Certainly there was engineering prior to 150 years ago, as the ancient pyramids, the aqueducts of Rome, and other engineering works mutely testify. The designing and building of these structures was not known as engineering, however.

Civil engineering was the first type of engineering to be recognized as a separate calling. Around 1750, John Smeaton, an English engineer, made the first recorded use of the term civil engineering. In 1818 the Institution of Civil Engineers was founded in Great Britain. That organization defined engineering as "the art of utilizing the forces of nature for the use and convenience of man." With the development of new fields of technological knowledge since then, many other fields of engineering have been established.

FEDERAL LAWS

A separate, recognized field of learning and the presence of societies of its members do not make a "profession." People do not have "professional" status merely because they have graduated from a school and joined a society. Perhaps it is best to consider for a moment the meaning of the term *profession.* It is not difficult to find definitions of the term. Webster's dictionary says it is "a calling requiring specialized knowledge and often long and intensive academic preparation." *Black's Law Dictionary* calls it "a vocation or occupation requiring special, usually advanced, education, and the labor and skill involved in a profession is predominantly mental or intellectual rather than physical or manual."

Although each of these definitions serves a purpose, each is brief at the expense of completeness. A more complete