

BOOK WRITING AND CHEMICAL ENGINEERING EDUCATION*

Rites, Rewards, and Responsibilities

“. . . of making many books there is no end; and much study is a weariness of the flesh.”

Eccl. 12:12

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ON THE WALL ABOVE my desk at home I have a map of Canada prepared by the cartographer Guillaume de L'isle in 1720. It shows the Great Lakes in about the correct relative positions, but their shapes are somewhat distorted. Much of the region, known at that time as La Nouvelle France, had been only partially explored, and consequently the map is clearly imperfect in the eyes of a 20th century American. The region to the west of Lake Superior was *terra incognita* in 1720. But incomplete as this map was it doubtless served explorers, government officials, and scholars of that time; subsequent explorations, many of them by canoe, led to better and better maps as the unknown gave way to the known. Every summer when I go canoeing in the Canadian “bush”, I can imagine the frustrations of the early explorers as they tried to push ahead through the waterways with their imperfect maps. Even armed with the best maps of our time, made from aerial photographs, we occasionally have encountered errors that have cost us time and trouble (including the interchange of a 2-foot rapids and a 50-foot waterfall on the Balmoral River in Ontario).

The 1720 map over my desk serves as a constant reminder that current books on science and engineering represent only an imperfect summary of our present knowledge and that beyond the covers of these books is a vast *terra incognita* which will be explored and charted by

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Bob Bird was an undergraduate at the University of Maryland, received a B.S. in chemical engineering at the University of Illinois, did his doctoral studies in physical chemistry at the University of Wisconsin, and had a postdoctoral appointment in theoretical physics at the University of Amsterdam. He joined the staff of the Department of Chemical Engineering at the University of Wisconsin in 1953 and has been there ever since (except for teaching for one semester in Delft, in Kyoto, and in Nagoya) serving as its chairman during the period 1964-1968.

those who follow us. The books of the future will reflect the new discoveries and will present the subject material in sharper focus and in better perspective. Meanwhile we make do with the currently available books, recognizing that mistakes and misconceptions contained in them will occasionally result in confusion and disaster—just as the errors in the Canadian maps have plagued the canoeist.

In educational circles today we hear a great deal about *teaching* and *research* (or, more often, teaching vs. research—as though these were mutually exclusive activities!). However we hear very little about the activity of *book-writing*, which ought to be included as a third principal

One bit of advice that cannot be overemphasized: allot some time for physical exercise and relaxation during the period you are working on a manuscript. During periods of intense mental activity, the mind sometimes gets 'clogged up.' I have found that a good long hike (preferably alone) once a week is essential to good bookwriting.

activity of a university teacher since it is concerned directly with the production, evaluation, organization, and dissemination of new knowledge. Therefore I thought it might be useful to use this lecture to focus attention on the "rites, rewards, and responsibilities" of book authorship. Since I have had the pleasure and good fortune to co-author several books [1] perhaps I can offer some appropriate words of encouragement to aspiring writers and even a few helpful suggestions regarding the art of writing. Maybe I can help others avoid some of the mistakes I've made. From time to time I will cite specific personal experiences in order to avoid discussing the problems of authorship in the abstract.

It is not my intention to discuss the history of chemical engineering and the role that various books have played in the development of the discipline. A brief historical summary was prepared in 1957 by Dr. Thomas H. Chilton [2], and Professor Olaf A. Hougen's Bicentennial Lecture [3] on Chemical Engineering History in 1976 contains additional material on chemical engineering textbooks. Still more information is to be found in two recent collections of articles on the history of chemical engineering [4].

WHAT KINDS OF BOOKS DO CHEMICAL ENGINEERS NEED

A library of professional volumes includes various classes of books: (i) *edited volumes* to present very recent developments by teams of experts; (ii) *research monographs* to catalog and evaluate the research published in the preceding 5-10 years; (iii) *treatises* to give authoritative, encyclopedic coverage of one particular topic; (iv) *textbooks* to set forth the basic ideas in the field in a form suitable for students; (v) *handbooks* to summarize standard results of widespread use; and (vi) *design manuals* to provide up-to-date procedures for practicing engineers. Each of these categories has a different audience, and each requires special organizational talents. Generally speaking there is a flow of information from (i) towards (vi) in the above listing—that is, from innovative, exploratory, and (sometimes) impractical ideas of the researcher all the way to the time-tested and reliable tools of the practitioner.

Along the way many ideas and methods are inevitably discarded, and only the most useful material survives to the arena of industrial practice. But without this constant exploration of new ideas and subsequent filtration, a profession can stagnate and atrophy.

In a very real sense good books bring about change. Some material from research-level monographs gradually finds its way into graduate and then undergraduate textbooks. New textbooks create changes in college courses and curricula; they can also produce changes in teaching methods. Handbooks and design manuals can ultimately bring about improvements in production methods.

The very boundaries of what we mean by chemical engineering are determined to a significant extent by the textbooks. The publication of "Principles of Chemical Engineering," by Walker, Lewis, and McAdams [5] at MIT about 60 years ago shaped the field of chemical engineering for many decades afterwards. And the trilogy of books by Hougen, Watson, and Ragatz [6] showed how the ideas of thermodynamics, kinetics, and diffusion could be used in the solution of key chemical engineering problems. These books were particularly influential because of their incisive organization of large quantities of material and the timeliness of the examples and problems. The future definition of chemical engineering will be established by books of the same quality and insight, but in new areas.

What are some of these new areas that are crying out for authors? No one person can supply such a list, of course, but I'll offer a few ideas:

- **Thermodynamics from the point of view of differential geometry (based on some of the developments of Weinhold [7])**
- **Separations processes in solids purification, with particular emphasis on the materials needed in the electronics industry**
- **Biochemical separations techniques**
- **Preparation and properties of catalysts**
- **Flow of powders and granular materials**
- **Applied mathematics for chemists and chemical engineers, illustrating some of the newest mathematical techniques (presented in the style of the imaginative text by Marshall & Pigford [8])**
- **Stochastic processes in chemical engineering**

- Colloids, emulsions, and suspensions, taking into account hydrodynamic, chemical electrical, and surface phenomena
- Chemical kinetics and reactor operation laboratory manual
- Fuels and their combustion, making use of the newest results from kinetics and transport phenomena
- Applied physical chemistry for non-chemical engineers, including some of the "classical" topics that have vanished from physical chemistry textbooks
- Product development, giving case studies on methods that have been evolved for making products with specified shapes, sizes, optical properties, corrosion properties, etc.
- Two-phase flows of polymeric liquids
- Thermodynamics and phase equilibria of polymeric systems

Better lists can undoubtedly be prepared by those under thirty-five, for they are the ones who should be itching to reorganize the profession.

WHO SHOULD WRITE?

Not everyone is suited to be an author. The principal requirements for bookwriting are: (i)

It may be that industrial organizations will wish to assist in the teaching of chemical engineering by allocating funds specifically for the preparation of textbooks.

thorough knowledge of the subject, (ii) skill in the use of the language, (iii) a highly developed sense of organization, (iv) much enthusiasm for telling others about the subject, (v) enough of a sense of impatience to get the job done, (vi) ability to interact with coauthors, (vii) a willingness to attend to details, (viii) familiarity with the key people in the field, (ix) an attitude of innovation, (x) ability to evaluate critically the published literature in the field, (xi) a good sense of humor, (xii) excellent health and stamina.

Very few people have all these characteristics. Consequently most writing projects are undertaken by a small group of individuals who can pool their knowledge and talents and make up for each other's shortcomings. This brings to mind the limerick [9].

*When twins came their father Dan Dunn
Gave "Edward" as name to each son
When folks said "Absurd!"
He replied, "Ain't you heard
That two Eds are better than one?"*

No doubt about it—two heads (or even three or four) are better than one when it comes to producing a responsible manuscript. I've never gone

solo in the book-writing business, and it's always seemed to me that it would be a lonely chore. True, there have been moments when I've had disagreements with my coauthors and had second thoughts about the joys of cooperative efforts, but usually out of these disagreements have come a better understanding of the subject and consequently more lucid writing.

In chemical engineering we should have more teams of authors in which one author is from industry and one from academia. In this way a balance could be achieved between industrial practice on the one hand and academic research on the other.

WHEN TO WRITE

The time is ripe for an author to begin writing a book when he has a burning desire to communicate his subject to his readership. Without an intense feeling of "missionary zeal" (why do missionaries get singled out for this honor?) a person probably will not have the energy and drive needed to complete the manuscript in a reasonable time. But one must have more than this compelling wish to communicate to his professional colleagues. There must be some element of *novelty* in the projected manuscript. Just what kinds of novelty should be required?

Novel ideas. If one has spent 10 or 15 years doing research on some particular topic and has been particularly successful and productive, the time may have arrived for him to collect his cumulative findings in a monograph. Preparing a book gives him a chance to summarize new achievements and put them in perspective. And who else is better prepared to do this than the originator of the novel ideas?

Novel survey of recent research. In every field—and particularly in rapidly developing ones—it is very important to prepare from time to time authoritative, critical, reviews of the recent advances and current status. To be useful such a review should try to resolve current controversies, suggest new experiments, establish new organizing schemes for the subject material, and compare and contrast competing theories or methods. Such an activity requires research status in the field, thorough familiarity with the key participants in the subject area, and the ability to recognize novel viewpoints and imaginative organization.

Novel organization of old ideas. We need textbooks in every profession. Inevitably much of the material in most textbooks will already be well-known and widely accepted. The novelty here has to be in the improved pedagogy, imaginative problems, sparking new applications of old material, new viewpoints made possible by recent research advances, and more up-to-date data, apparatus, computing procedures, and materials. Even for old subjects, such

as thermodynamics and fluid dynamics, much can be done to create textbooks with a high degree of novelty.

The key words throughout are “novelty”, “creativity”, and “imagination”. If a prospective author is not in a position to contribute new, creative, and imaginative thoughts of some kind, it is not yet time to put pen to paper (or sit down at the keyboard of a word processor).

HOW TO GET READY TO WRITE

Before the actual writing process begins, there are certain preliminary matters which should be attended to if the writing is to proceed efficiently and if the final printed volume is to be sharply focused.

Establishment of Aim, Scope, and Level. Book-writing demands dedication to a single goal. At the very outset the authors should specify the audience for whom their book is intended and the scientific background that the audience will have. The purpose of the book should be carefully spelled out and the boundaries of the subject material should be agreed on. Keep in mind the German proverb “*In der Beschränkung zeigt sich der Meister*”. (The true master knows how to limit himself.)

Preparation of an Outline. Book-writing demands organization. A list of chapters should be prepared and then the section headings within each chapter should be agreed on. Every effort should be made to arrange the subject material in such a way that the *organization* of the material jumps out at the reader when he looks at the Table of Contents. One of the most important contributions of the authors is to provide the reader with a framework for the subject into which the details can gradually be filed away. Authors should spend a lot of time on arranging their table of contents and choosing the chapter titles in such a way that the reader understands the anatomy of the subject material.

Allocation of Time. Book-writing demands large blocks of *uninterrupted working time*. The writing should be done as quickly as possible in order that the authors maintain momentum and continuity of thought. If the writing is spread out over too long a period, much time and energy are frittered away in rereading and updating previous chapters.

Establishing a Place to Work. Book-writing demands *isolation*. It is very important to find a room in the library, a room at home, an abandoned store-room or any out-of-the-way place (preferably phone-less), where the book-writing activity can occur. All of one’s writing materials, reference books, dictionaries, reprints, and journals should be moved into this area away from the hurly-burly of everyday professional life. This may mean a common room where all coauthors work together, or it may mean separate rooms for each coauthor. In any case, this Shangri-La should be inviolate.

Suspension of Unnecessary Activities. Book-writing demands sacrifices of the authors, particularly in curtail-

ing or eliminating social activities, attendance at meetings, participation on committees, and time spent on hobbies. One simply has to *get one’s vectors lined up* so that for the book-writing period most of one’s energies are directed towards a single goal.

Establishment of a Style Sheet. Book-writing demands consistency. Much time can be saved if at the very outset the authors can agree on certain questions of *nomenclature, notation, and style* (by the latter we mean those picky little details such as whether you write Eq. 5.2-1, Eqn. (5.2-1), eq. [5.2-1], or (V(2).1)). One can get a lot of help by imitating the style of some book that one admires, or one can get valuable tips from the carefully prepared style manuals provided by the publisher.

After the index has been shipped off to the publisher, there is a several-month waiting period until the author finally gets the first copy of his new book. This period seems interminable . . . Most authors about this time experience a rather serious “post partum” depression.

Yes, book-writing demands a lot of preparation and commitment right from the beginning. Failure to get the writing done within a reasonable time span can result in an out-of-date manuscript or one that doesn’t have much coherence. Failure to establish a suitable place for writing can result in inefficient work habits, interruptions, and errors. Failure to establish a style sheet can result in a lot of rewriting and last-minute changes. Failure to establish the aims and to prepare an outline can result in chaos and confusion, and even ultimately the abandonment of the project. Many manuscripts have withered away and authors have become frustrated or embittered as a result of inadequate preparation.

HOW TO WRITE

The actual production of manuscript copy is a very personal matter. Each author has to develop his own *modus operandi*. Some like to have a daily goal of, say, four typed pages; others like to work for, say, three hours per day; still others like to work in spurts. Some like to work with pencil and yellow pad, using an eraser as they go; some scribble their thoughts on scratch paper and then type a neat manuscript from their rough notes; still others prefer to use a dictating machine; very rapidly word processors are replacing the pencil, pen and typewriter.

Regardless of the writing procedures that an author chooses to adopt, there are many points to keep in mind to insure quality of the finished product:

Bibliography. Those scholarly-looking footnotes at the bottom of the page are not put there as a show of erudition. They serve two purposes: to tell the reader where additional information may be found in the technical literature, and to thank originators of the ideas for their contributions. It is essential to maintain an accurate bibliography and to keep meticulous track of the sources of all material used. It is a source of lasting embarrassment if later on you find you have slighted a colleague by failing to acknowledge his contribution.

Orientation. It is vital to provide the reader frequently with introductory or concluding paragraphs that give him orientation and perspective. It is difficult enough to master the details of any technical subject, but it is even more difficult to understand the status, principal challenges, or limitations of the subject. It is also very valuable to supply generous cross-referencing within the book to help the reader understand how various topics are interrelated.

Equations. In presenting derivations it is, of course, essential that the equations be correct, and in the manuscript they should be written precisely in the form that they are to be typeset. But that is not enough. One should also group symbols in meaningful ways so as to suggest or emphasize the physical content and maintain the groupings carefully in a sequence of equations. The use of dimensionless ratios is particularly helpful. There is a lot of artistry involved in displaying derivations of equations; the equations can be remembered more easily and their physical meaning better understood if attention is paid to the arrangement of the mathematical symbols and if symbols are used that have mnemonic value. My mentor, Professor Jan de Boer at the University of Amsterdam, once cited the Dutch proverb *Set oog wil ook wat hebben* (the eye also wants to have a treat—i.e., it is not enough to have the equation correct, but it must also look artistic!).

Graphs, Charts, and Tables. Much engineering work involves the use of tabular or graphical summaries. Reliable, accurate, easy-to-use reference material is indispensable. Here again there is a lot of artistry involved in cramming as much as possible into a visual display that can give the reader a good overview of a lot of information.

Illustrative Examples and Problems. Professor Olaf A. Hougen said that if you can't make up good problems and illustrative examples for a topic, then that topic may not be worth teaching to students in an engineering course. Certainly one of the great strengths of the Hougen-Watson-Ragatz series was the imposing collection of worked and unworked problems. Carefully prepared illustrative examples are often more helpful to students than long discussions in the abstract. Also for industrial practitioners an illustrative example is extremely useful for self-instruction. One time when Professor Hougen was visiting a blast furnace on a plant trip with a group of undergraduates, he asked one of the engineers how they made computations for their plant; the engineer said that he had found an excellent book that told just how to do it—and then he produced a copy of Professor Hougen's own book on material and energy balances, which had an extensive illustrative example on blast furnaces! In writing text-

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books, my coauthors and I often found that we had to go back and change the main text or include some additional tables after trying to work out the details of our own problems and examples.

Solutions Manual. Most professors of engineering are overworked, and having a solutions manual for grading the homework assignments is enormously helpful. Also, as we all know, it not infrequently happens that a teacher is pressed into service for teaching some course in an area where his own background may be only minimal; a solutions manual can actually help to instruct the teacher. If the authors prepare the solutions manual right along with the textbook, they have the additional peace of mind that their problems actually can be worked and that the solutions are physically reasonable.

In every part of the manuscript preparation one very good motto is: *KEEP IT SIMPLE*. The learning of technical material is difficult, and the reader does not appreciate it when the author thoughtlessly or purposely introduces unnecessary complexities. Tables, notation, equations, graphs, bibliographical listings—all of these should be arranged as simply as possible. Simplicity in sentence structure and vocabulary is also highly desirable. There's no need to inundate the reader with arcane incantations or sesquipedalian persiflage—that kind of language offends most engineering readers; furthermore we must remember that science and engineering are international, and that the native language of a large percentage of the readers is not English. Making things simple for the reader demands a lot of effort by the author. It requires great talent and insight to distil out of the vast and conflicting literature the essential ideas on a given subject, but this is one of the obligations of authorship.

One bit of advice that cannot be overemphasized: allot some time for physical exercise and relaxation during the period you are working on a manuscript. During periods of intense mental activity, the mind sometimes gets 'clogged up'. I have found that a good long hike (preferably alone) once a week is essential to good book-writing. Five or six hours out-of-doors is worth far more than the same amount of time behind the typewriter. After one or two hours of walking, the mind begins to 'come unclogged', and ideas

about arrangement of material and detailed explanations begin to flow freely. I always take along a pen and a stack of 3 x 5 cards to jot down the ideas as they come. After a hike I come back to the manuscript physically relaxed and mentally aired out, and I usually have several cards full of new thoughts.

INTERACTIONS WITH THE PUBLISHER

My own dealings with publishers have been generally very cordial. Some of my colleagues have, however, had unpleasant experiences; these may in part have resulted from not recognizing what their relation to the publisher would be. Just what are some of the ways in which authors interact with publishers?

The Contract. Many authors are so delighted and flattered that someone is actually going to publish their manuscript that they really do not give the contract much thought. They should consider carefully not only the question of royalties (which can be computed in many different ways), but also such questions as the making of corrections in later printings, the choice of type fonts available, the format of the book, the form in which art work is to be delivered to the printer, the status of the book if it goes out of print, and the type of paper and binding to be used. It pays to discuss contracts with colleagues who have already published to find out what problems they may have had. Authors should remember that they are entering into a business agreement, and if the nature of the agreement is thoroughly understood the collaboration will be more harmonious. Most publishers have standard printed contracts, but authors should not hesitate to request modification of the wording where appropriate.

A Visit to the Publishing House. If possible one or more of the authors should visit the publisher's. Many of the editing and production problems are much more easily handled if the authors have met the key staff members of the publishing team. By seeing how various parts of the production are performed, authors can avoid making unreasonable demands on their publisher.

Manuscript Review. The publisher will normally send the manuscript to one or more experts in the field to elicit comments. This is very beneficial to the authors, and the reviewer's criticisms should be taken seriously. The authors should also get comments from colleagues or students. At the time we published *Transport Phenomena*, our publisher (John Wiley and Sons) prepared a "preliminary edition" which was used for two years by us at the University of Wisconsin and also by Professor J. E. Powers at the University of Oklahoma, Professor J. Dranoff at Northwestern University, Professor E. Weger at John Hopkins University, and Professor K. M. Watson at Illinois Institute of Technology. The advice that we received from them and their students was invaluable. The students' comments were often very blunt and vitriolic, but they had a sobering influence on the three of us. And

it was Professor K. M. Watson who suggested to us that the problems at the ends of the chapters ought to have a subscript to tell how difficult the problems were. With the word processors now available, it should be possible for authors to put out their own preliminary editions before sending a final manuscript to the publisher.

Copy Editing. Most authors hate the copy editors. These faceless people (unless you have actually visited them on their home ground) correct your grammar, turn your sentences around, and insert schoolmarmish queries in the margins. Adults just don't like to be treated that way. In the long run, I have profited from my interactions with the editors; they have a tough job to do, and authors should learn all they can from those "purple pencil people" who deface their cherished manuscript. One does, however, have to check all the purple marks very carefully to be sure that meanings are not changed and that correct equations are not transformed into gibberish.

Proofreading. Most authors regard this activity as extremely distasteful. It is a demanding, exhausting chore that cannot be turned over to wives, assistants, or students. This is the authors' last chance to be sure that errors have not been introduced by the editor or the printer; the authors may even find that some of their own errors have managed to survive to this stage. No matter how careful one is, a number of errors will nonetheless slip through. Some of these will be trivial misprints, and occasionally an erratum will be funny—such as the appearance of the word 'Bird' in Fig. 9.L on p. 305 of the first printing of *Transport Phenomena* [1] (all india ink drawings are marked with the name of the senior author, and in the final composition of this page the author's name was not whited out). Another amusing erratum is the appearance of the word "theological" in lieu of "rheological" in Dr. J. R. A. Pearson's book on polymer processing [10]. It's impossible to eliminate all errors, of course, but the authors have the responsibility to their future readers to do their level best.

The Index. By the time the authors have written the manuscript, done battle with the copy editor, and slaved over several sets of proofs, they are usually approaching a state of mental and physical ruin. It is at this time that they are asked to prepare the index, and this task is also one that cannot be delegated. There's the story about the arrogant professor who had just finished a 1200 page book on ornithology, and ordered his graduate students to prepare the index. The students, chafing under this assignment got revenge by inserting an entry: "Birds, for the, 1-1200". A number of otherwise excellent books have been seriously flawed by the authors' irresponsibility with regard to preparing an index.

I said at the outset that my own relations with the publishers have generally been very pleasant. I do recall, however, that I got rather upset with Mr. J. S. ("Stet") Barnes of John Wiley and Sons because he wouldn't let me put a Dutch proverb at the end of the preface of *Molecular Theory of Gases and Liquids* [1], since Dutch proverbs don't have much currency outside of The Netherlands. Of course he was right. But six

or seven years later, when writing the preface for *Transport Phenomena* [1] I decided to get even by including "secret messages" in the preface and postface of the book in the form of acronyms. When the book was published I was invited to attend a luncheon for the Wiley sales force to let them ask me some questions about the new book. At the end of the question-and-answer session I reminded Mr. Barnes of our earlier altercation regarding the Dutch proverb, and announced that I had at last succeeded in evening the score by including hidden messages. Mr. Barnes turned several colors of red, grabbed a copy of the book, and began deciphering the messages; he was visibly relieved to find that the messages were not directed at him personally or at the publisher.

PRE- AND POST-PUBLICATION EVENTS

After the index has been shipped off to the publisher, there is a several-month waiting period until the author finally gets the first copy of his new book. This period seems interminable. One has to start putting his life back together again and do all kinds of chores that had been put off. But the conscientious author begins to have nagging doubts as to whether he really left the reader with the correct impression in Chapter 6, and whether he should really have included Table III in Chapter 8, and whether a derivation couldn't have been presented more simply in Chapter 11. And perhaps he discovers to his horror that a key reference has been omitted in Chapter 9 or that a life-long friend and colleague was omitted in the acknowledgments. Most authors about this time experience a rather serious "post partum" depression.

The day that the first copy of the book arrives, there are feelings of elation, accomplishment, relief, and pride, but mingled with feelings of dissatisfaction, and these latter feelings usually are reinforced by the unwelcome discovery—on that first day—of several misprints or errors. This odd collection of emotions is known only to authors. But the period of depression is not yet over, because it will be six to twelve months before the book is reviewed in the professional journals. During this period of waiting the authors tend to magnify out of all proportion the errors that they find. In addition, as scientific and engineering research surges onward, the authors realize that their opus magnum is already getting out of date. It is very important for book-writers to be prepared for this stage of their lives; it's a good time

for the development of a new hobby, a trip to Tasmania, or planning the next book (before you do that, however, you should join your local chapter of "Authors Anonymous").

In the wake of the publication one does have to maintain a file of errata, unpleasant though this chore may be. Authors do appreciate it when readers take the time and trouble to write or phone them about mistakes that have been found, since these errors can be corrected in later printings. Also, many authors maintain lists of "corrigenda" (I think this word is somewhat more friendly than "errata"), which they duplicate and make available to other workers in the same field. So don't hesitate to write to authors and let them know how their books can be improved.

As a matter of fact, after you publish a book you have correspondence with all sorts of people all over the U.S. and abroad. I've had letters from students wanting topics for term papers, from people in industry asking for the solution to some problem at the end of a chapter in connection with a specific design problem, from students who claim that they were graded incorrectly on an exam problem by their teacher (and they want me to be the referee), from professors who don't like my notation or units, etc.

Since becoming an author I don't hesitate to write other authors when I feel shortchanged. During my first week of teaching at Kyoto University, I found it was impossible for me to get a ham sandwich without mustard at a nearby restaurant because I didn't know how to say 'without'; that word was not to be found in the grammar book [11] (by Professor S. E. Martin of Yale) I had been studying. Right away I wrote to Professor Martin, explained my dilemma, and sent him a list of errata I had found in his textbook. He responded promptly and kindly sent me a complimentary copy of the newest edition of his book. Several years later, when visiting the ChE Department at Yale, I went over to see Professor Martin. He greeted me immediately with "Ah, yes, you're the one who couldn't order a sandwich without mustard!" Don't be timid about writing to authors—they enjoy hearing from their customers.

Of all the emotional experiences after publishing a book, none can beat that crushed feeling you get when you see a copy of your book in the used-book section at the bookstore. Then you open it and see the underlined paragraphs, the penciled notes about exam dates in the front cover, and

the comments in the margins (perhaps even an occasional unkind remark about the authors). You realize then that some student tried to study your book and was turned off by the subject, or by your style of writing, or maybe because you as the author didn't somehow have that reader in mind. The time to think about that discouraged student is not after the book has been published, but while the manuscript is being prepared!

REWARDS

Book-writing should not be undertaken to gain fame and fortune. If you want to make a fortune you're better off to buy real estate, do consulting, or study the art of investing. Book-writing is no guarantee of fame, since one can damage one's name if the final product does not meet with the approval of the professional community. No, the rewards of book-writing are of a different nature.

First of all there is the opportunity for scholarly growth. By the time you have completed a book manuscript you have an extremely detailed and thorough knowledge of a subject. This in turn enriches your capabilities as a teacher, researcher, consultant, or designer. Also, having spent months in reading about many facets of the subject and having devoted months to organizing the material, you are in an excellent position to keep up with the burgeoning literature of the field. In addition, if your book has been well received, many people will send you reprints of their work and copies of their books just as a question of collegial courtesy, and this also makes it easier to keep abreast of the latest advances. Book-writing also makes you aware of the problems that most urgently need to be attacked in your field, and hence you are led into new research vistas.

The second reward of book-writing is the feeling of service to the professional community—and this is an international community. Considerable satisfaction results from knowing that one has produced a manual, a textbook, a monograph, or a handbook that will help other people to do their jobs better or to help them to acquire new knowledge.

And finally the third reward for book-writing is the learning from one's coauthors. I have been very fortunate to have collaborated with some truly extraordinary people. From *Joe Hirschfelder* I learned that science is just one thrilling adventure, and that numerical tables should never contain any errors. Every encounter with *Chuck Curtiss* has resulted in his patiently teaching me

some new technique from his seemingly infinite supply of theoretical tricks. *Warren Stewart*, who seems to have a photographic memory and total recall, introduced me to simultaneous heat-and-mass transfer with and without chemical reactions; his dedication to expository and numerical accuracy never ceases to amaze me. I have valued very much *Ed Lightfoot's* almost iconoclastic approach to science and engineering, which sometimes knocks you off balance and makes you think about subjects from a totally different point of view. *Bill Shetter* has helped me to appreciate Dutch literature and linguistics, and never to trust foreign-language dictionaries blindly. My colleagues *Ed Daub* and *Nob Inoue* taught me a lot about the subtleties of the Japanese language and the scholarly contributions of Japanese engineers and scientists. And my former students *Bob Armstrong* and *Ole Hassager* rejuvenated me by helping me to understand better some of the notions of modern continuum mechanics, rheology, and kinetic theory. All of these people were lots of fun to work with, and their constructive attitudes and great sense of humor made each publishing undertaking an adventure rather than an ordeal. Sure, we had our moments of misunderstandings and perhaps even a harsh word now and then, but the teamwork and camaraderie are what we remember. I treasure the memories of our joint ventures, and would like to thank all of my coauthors for enriching my professional and personal life. I know this may sound sentimental, but friendships forged in manuscript-writing and tempered by the galley-proof reading are very special.

ENCOURAGEMENT FOR BOOK-WRITING

Most book-writing is done nights and weekends by dedicated authors whose spirit of service is almost overpowering. It requires a lot of personal sacrifices. There are only limited possibilities for obtaining a grant of financial aid to write a book, and thereby have a substantial block of time for bookwriting. Guggenheim grants have been used for preparing research monographs, although chemical engineers do not seem to have made much use of them for this purpose. In chemistry, the George Fisher Baker Lectures of Cornell University have enabled outstanding scientists to give special lectures and prepare books; this series has been eminently successful with *Flory's Polymer Chemistry*, *Debye's Polar Molecules*, and *Pauling's Nature of the Chemical Bond* being a few of the trail-blazing volumes resulting from

this endowed chair. At the University of Wisconsin we have established the Olaf A. Hougen Professorship, patterned somewhat after the Baker Lectures, and we hope that the contributions of the Hougen Professors through the years to come will be influential in the future teaching and research in chemical engineering. Other universities ought to consider setting up similar endowed chairs to honor eminent authors and researchers.

It may be that industrial organizations will wish to assist in the teaching of chemical engineering by allocating funds specifically for the preparation of textbooks; this might be a useful alternative or supplement to the "young faculty grants", which have been very much appreciated by the universities. The American Institute of Engineers may want to reexamine its "Institute Lectureship" with an eye to encouraging the improvement of research and teaching in the U.S.; originally the Institute Lectureship Award carried with it the responsibility for preparing a monograph, published by AIChE, but it is my understanding that only several of the award winners have fulfilled that obligation. In the frenetic professional world of today, it is probably asking too much for the Institute Lecturer to prepare a monograph without providing some released time for undertaking the manuscript preparation.

Book-writing is not even encouraged in some institutions. I have heard of several chemical engineering departments in which young faculty are actively discouraged from undertaking any textbook writing by intimations that such an activity will in no way contribute to their chances for tenure. And our present system of research grants, with the continual scrambling for funds and requirement of continuity of productivity, almost prohibits an active researcher from taking a year or two off to write a first-rate book. Those who do have the temerity to do this risk losing their grants or their health or both.

BOOK-WRITING IN THE FUTURE

When Joe Hirschfelder, Chuck Curtiss, and I worked on the manuscript for *Molecular Theory of Gases and Liquids* [1], about thirty years ago, there were no Xerox machines, and manuscript copies had to be prepared using carbon paper. All equations had to be filled in by hand, and since we had no correction fluid at that time, erasers, and the inevitable smudges were just part of the book-writing scene.

In the near future the entire book-writing and book-publishing process will undergo an upheaval [14]. Manuscripts will routinely be prepared by word-processors, and publishers are already issuing instructions to prospective authors about the use of these devices [14]. Manuscripts will not be mailed to the publisher, but instead floppy disks and tapes will be sent. The copy editing will probably be done with word-processing equipment, and the page layout, pagination, indexing, preparation of drawings, checking of cross references, and other tedious chores will become automated and computerized. This will relieve a lot of the drudgery of book-writing and make it easier for the author to concentrate his efforts on the technical content of his book.

Publishers are still faced with several problems that are particularly difficult to solve. The first is the widespread use of copying devices to make copies of parts or all of books. And the second is the widespread publishing of unauthorized editions of books in other countries. It is the publisher, after all, who has to bear the cost of identifying manuscripts, reviewing of manuscripts, editing of manuscripts, preparation of artwork, page layout, typesetting, advertising and paying royalties to the authors. When large scale photocopying occurs it clearly upsets the economics of the industry and neither the author nor publisher are properly remunerated for their labors.

CONCLUSIONS

Let us now return to the Biblical quotation at the beginning: ". . . of making books there is no end . . .". Although the methods for preparing manuscripts and producing books will undergo tremendous changes in the next decade, the need for books is still going to be present. If young people in our profession are going to be trained at our institutions of higher learning, we must have lively, up-to-date, and responsibly written textbooks. As Carlyle said: THE TRUE UNIVERSITY OF THESE DAYS IS A COLLECTION OF BOOKS, and it is no wonder that these words are found engraved over the portals of many university libraries. The industrial practitioners also need source books on chemical engineering. As Dr. Thomas H. Chilton (of the Engineering Department of DuPont) said [2], ". . . there must be more books, for engineering data and the interpretation of results are fundamental needs. The industry grows not only on

transmitted art and practice, but also through the careful and long study and reinterpretation of described practices, art, and data.”

The field of chemical engineering will inevitably be known and measured by its journals and books. It behooves us, as professionals, to offer encouragement to willing and responsible book authors and to strive for the amelioration of the conditions under which these books are prepared. The establishment of special book-writing chairs at universities, an annual AIChE supported monograph, and industrial sponsorship for certain kinds of books could profoundly influence the direction and speed of progress in the profession of chemical engineering.

In conclusion I would like to say a few words about “style” in book-writing—“style” in the general sense of the word. In a recent issue of the *Wall Street Journal* [15], there was an article by James Sloan Allen on the subject of style, particularly with regard to the performing arts. But his comments apply also to book-writing, teaching, and research. He says that by style he means “that near-magical touch of artful individuality that elevates most anything one does above the routine, the common, or even the respectable. . . . There is more to style than well-wrought appearances. For there must be something within the performer, some attributes of character, that makes style possible. These attributes are imagination and will or discipline.” The books that lead chemical engineering into the future will be those imaginative and innovative volumes written by self-disciplined, responsible authors. □

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REFERENCES

1. J. O. Hirschfelder, C. F. Curtiss, and R. B. Bird, “Molecular Theory of Gases and Liquids”, Wiley, New York (1954); R. B. Bird, W. E. Stewart, and E. N. Lightfoot, “Transport Phenomena”, Wiley, New York (1960); R. B. Bird and W. Z. Shetter, “Een Goed Begin”, Martinus-Nijhoff, The Hague (1963); E. E. Daub, R. B. Bird, and N. Inoue, “Comprehending Technical Japanese”, Univ. of Wisconsin and Univ. of Tokyo Presses (1975); “Dynamics of Polymeric Liquids”, Vol. 1 by R. B. Bird, R. C. Armstrong, and O. Hassager and Vol. 2 by R. B. Bird, O. Hassager, R. C. Armstrong, and C. F. Curtiss, Wiley, New York (1977).
2. T. H. Chilton, in “The First One Hundred and Fifty Years”, John Wiley and Sons, Inc., New York (1957).
3. O. A. Hougen, “Seven Decades of Chemical Engineering”, *Chemical Engineering Progress*, Jan. 1977, pp. 89-104.
4. W. F. Furter (Ed.), “History of Chemical Engineering”, Adv. in Chem. Series, No. 190, Amer. Chem. Soc., Washington, D.C. (1980); W. F. Furter (Ed.), “A Century of Chemical Engineering”, Plenum Publ. Co., New York (1982).
5. W. H. Walker, W. K. Lewis, and W. H. Adams, “Principles of Chemical Engineering”, McGraw-Hill, New York (1923).
6. O. A. Hougen, K. M. Watson, and R. A. Ragatz, “Material and Energy Balances”, Wiley, New York (1954); O. A. Hougen, K. M. Watson, and R. A. Ragatz, “Thermodynamics”, Wiley, New York (1959); O. A. Hougen and K. M. Watson, “Kinetics and Catalysis”, Wiley, New York (1947).
7. F. Weinhold, “Metric Geometry of Thermodynamics”, *J. Chem. Phys.*, **63**, 2479-2501 (1975).
8. W. R. Marshall and R. L. Pigford, “The Application of Differential Equations to Chemical Engineering Problems”, U. of Delaware Press, Newark, Del. (1947).
9. Limerick by Berton Braley, on p. 96 of “Out on a Limerick”, by Benett Cerf, Pocket Books, Inc., New York (1962).
10. J. R. A. Pearson, “Mechanical Principles of Polymer Melt Processing”, Pergamon, New York (1966), p. 1.
11. S. E. Martin, “Essential Japanese”, Tuttle, Rutland, Vt. (1956).
12. A. A. P. Faculty Service, “An Author’s Guide to Academic Publishing”, College Div., Assoc. of Amer. Publishers, 1 Park Ave., New York, New York, 10016.
13. M. H. Bruno, “Status of Printing in the U.S.A.—1981”, New England Printer & Publisher, July 1981, pp. 27-49.
14. P. Seybold, “An Introduction to Word Processing for Wiley Authors”, John Wiley and Sons, New York (1982).
15. J. S. Allen, “The Importance of Style in Art and Life”, *Wall Street Journal*, Nov. 26, 1982.