with which we are concerned also involves action. It takes a lot of faith in your ideas and yourself to proceed to test your idea and finally commercialize a truly new product. As natural scientists it is our job to observe and study. As technologists it is our job to connive out of this information something which will do the job better, cheaper and easier than it has ever been done before.

I think we can sum up the situation by repeating Locke's quotation—"This source of ideas every man has wholly in himself."

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# WHAT AUTHORS AND EDITORS CAN DO TO PROVOKE THE CREATIVE REACTION*

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Our first clue is obvious in the definition of the word "create." For if *you* will invest enough thought in your subject to achieve and communicate "a new form, office, or character," the reader who remains unstimulated is mired pretty deeply in his rut.

How much are you willing to do to get through to your audience?

In a lecture a few years ago to the Washington Junior Academy of Sciences, Dr. Hubert N. Alyea of Princeton went at a clip that reminded one of an L-P record played at 78 r.p.m. In one unforgettable sequence, Prof. Alyea seized two pressurized $CO_2$ fire extinguishers and rushed down the aisle through the audience, spraying carbon dioxide snow on both sides and shouting above the uproar his observations about phase change, the gas laws, and the relation between heat and temperature.

The ACS had a meeting in Buffalo in 1952—about the time the new "miracle" synthetic textile fibers were just beginning to earn major acceptance into the clothing field. The morning after a major symposium on the subject was presented at the meeting sessions, the front page of one of the Buffalo papers carried a picture of a fully-clothed, upper-middle-aged man standing in a hotel bathtub under a running shower. The man was the late Dr. Gustav Egloff, vice president of the Universal Oil Products Company. A lot of non-chemists in Buffalo (and probably quite a few chemists as well) got a pretty vivid impression of the water- and wrinkle-resistance of the new textiles. Also, many of them never again forgot that the petroleum industry had made its own significant contribution in developing petrochemical building blocks to an important new industry. That, incidentally, also probably will be the only time in history a bathtub picture of a middle-aged gentleman will ever make the front page of a newspaper.

In both these instances, a creative communicator presented a well-known item in an unusual context. In both instances, a lively interest and appreciation was awakened beyond any shadow of a doubt. And interest and knowledgeable appreciation are mighty good initiators for the creative process.

The effect of context is almost always important. And effectiveness can be achieved with either the shock-power of unexpected deeper pertinence, or of pertinent—and thus permissible—impertinence. One of my happier personal experiences was the way I finally discovered how to describe to the non-technical visitors the Tennessee Valley Authority's fertilizer phosphate research and production activities at Muscle Shoals, Alabama. This was in my first job after I graduated from engineering school, and pride of profession impelled me to seek some explanation that would do at least some justice to the significant process factors. Success came with recognition that the chemistry of all the processes could be explained in a single reference framework, the fluorine in the fluoroapatite constituent of the phosphate rock we were using. That fluorine, present in the calcium fluoride 'free loader" attached to an otherwise healthy and normal tricalcium phosphate molecule, had to be dislodged before the phosphate could be "digested" by the hungry roots of plants. That single explanation sufficed to convey some appreciation of the common purpose of fusion heat, electric-furnace treatment, or acids and alkalies in various fertilizer process investigations then under way in T.V.A.'s laboratories and pilot plants. And, I must add, it triggered a line of speculative technical thinking on my part that was rooted in more perceptive awareness of a key requirement than I had ever felt earlier.

These examples are taken from instances where the spoken word rather than the printed page was the vehicle of communication. Yet I believe they are valid in the context of my assignment. The interplay of established fact and unexpected association, which presents a new vantage point and challenges the observer to seek additional ones from the terrain he commands, can be accomplished equally on paper—as this discourse hopefully attempts to demonstrate.

In the realm of the printed document, consider thoughtfully the mode of presentation most likely to engage the greatest set of associations in the mind of the reader. The consequences can contribute much to the stimulant quality of your text. The alternative possibilities inherent in an alumina-from-clay process are illustrative. If your principal audience is the chemist, give him the equations (Fig. 1). His selectively tuned antennae will instantly begin to sense the nuances of main and byproduct reaction tendencies, thermodynamic threshholds, the implications of impurities in economically available reactants, and a host of similar hazards, possibilities, and half-glimpsed opportunities. The process

**SINTERING STEP**

$$3(Al_2O_3{\cdot}2SiO_2) + 17CaCO_3 = 5CaO{\cdot}3Al_2O_3 + 6(2CaO{\cdot}SiO_2) + 17CO_2$$

clay — limestone — sinter

**EXTRACTION STEP**

$$5CaO{\cdot}3Al_2O_3 + 3Na_2CO_3 + 2NaHCO_3 = 6NaAlO_2 + 2NaOH + 5CaCO_3$$

sinter — extracting soln. — extraction soln. — residue

**PRECIPITATION STEP**

$$6NaAlO_2 + 2NaOH + 9H_2O + 5CO_2 = 3Na_2CO_3 + 2NaHCO_3 + 6Al(OH)_3$$

extraction soln. — regenerated extracting soln. — aluminum trihydrate

Fig. 1.

engineer will find his richest meaning in the flow sheet (Fig. 2). When the author's purpose merits it, the flow sheet can

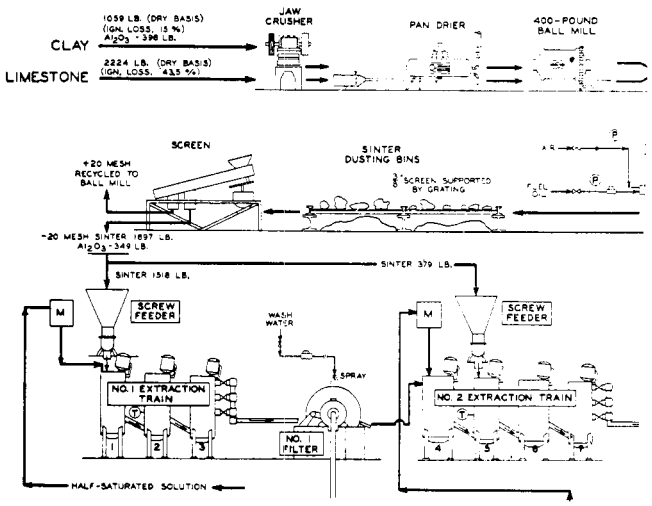


Fig. 2.—The process specialist will grasp engineering aspects with particular awareness when a flow sheet is employed.

be carried forward to the point where the types of unit operations equipment are visually symbolized and a record provided for the pilot-plant experience regarding materials losses and conversion inefficiencies. To the process engineer, it tells a tale of travel, toil, and durance vile—and hints of buried treasure—to match the best story Sinbad ever spun.

I find it difficult to visualize a technical audience that is properly served through words alone. The use of provocative symbolism—whether the chemical equation, the flow sheet, the photograph, the cut-away diagram—enormously advances the cause. For they call forth additional associations—the specialized technical culture—that are common to the author and reader.

And where the mechanics permit, by no means overlook the potentials of the motion picture, color, and the sound track. Stop-motion, high-speed photography, and repeat-sequence techniques can give powerful assists in "shifting gears" to bring certain phenomena into size or time-rate scales that communicate much greater significance to the human observer.

Until your work allows you to erect a new and technically logical construction that rests on other generally accepted knowledge, you should not, of course, write a paper at all. The roots must grip the ground firmly, and the trunk must sustain the weight of the branches. But there is really no need to prune your young oak so severely that all the growth buds are removed. Do you recall, as I do so well, the sharp twinge of envious frustration as you read a triumphant account, flawless as a fairy story in the perfection of the achievement, that seemed to close the book forever on another classical question of science? Somehow, the myriad challenges that remained, the new puzzles, half-seen, teasing the victor past a well-deserved bed of rest and on to further pursuit, never were mentioned. Yet here was the very point in the story where the tinder was most ready for the spark. Have the courage and the generosity to share with your audience a little of the half-understood, the disconcertingly unexplainable. Give your reader a chance to make something more than a spectator sport of your game.

A dash of the speculative can be added without any unbending from phraseology of the utmost rectitude. And for some few audiences and occasions, good taste may dictate such reserve. But usually you can take a further step toward the rapport that encourages the creative response by expressing some of your personal interest and enthusiasm in the work you are describing. I think I can understand and and sympathize with the masklike impassivity affected by teen-age rock-and-roll dancers, considering both the horror of their physical predicament and their frail self-assurance. But scientific authors seldom need to present papers under such near-catastrophic conditions.

Some scientists, in fact, are so comfortable in their subject matter that they may tease it with the use of humor. Sometimes it is affectionate, though not always. But in every instance I can visualize concretely, the humor retains a basic undertone of respect for what is, in the ultimate, a fundamentally serious and scrupulously honest domain of human experience.

Editors have the power to control style. Thus, most of what has gone before also bears critically on the editor's function, although the construction labor may fall on the author's shoulders. The editor can cajole, present illustrative examples, or even deny his pages to an author who misplaces dignity ahead of communicative adequacy. Journals are low-impact, mass communication vehicles, and the modern editor is well-advised to sense the great ease with which his sacred pages can rest unturned. On behalf of his functional mission, the factors that get his publication read are comparable to the technical value of its contents. Merit of content is certainly not the exclusive determinant of reading usage.

Like the author-lecturer, the editor has special tools he can employ to aid communication—and evoke reaction. He has the mechanical tools of type, ink color, and page layout. He has the intellectual tools of grouping like or contrasting topics, the commentary-"blurb," the use of photograph, sketch, or cartoon to highlight unusually provocative facts or conclusions. With such tools he can supplement the author's efforts. And he can go beyond the point the author can reach, by effective treatment of groups of papers. He can commission "pro" and "con" presentations, eulogize a significant achievement, view with alarm, point to a need—or an opportunity.

In this respect the editor is more flexible than the author. He can speak with acceptance from more rostrums, and can exploit more "one-of-a-kind" opportunities to provoke, stimulate, prod, awaken, alert, titillate, amaze, intrigue, puzzle, confound, contrast, prophesy, argue, speculate, . . . , in a word, to reassure his loyal readers that a few growth-buds remain on the tree of knowledge, which they can help to cultivate to produce the new wood and fresh blooms of a future day.