ous substitution between capital and labor as a result of shifting input prices and changing technology. Nevertheless, for many purposes, input-output is the best initial approximation of the structure of industry (taken as whole) currently available. Leontief has devoted a lifetime to the technique. Its wide adoption in the United States and abroad speaks for itself as a measure of his achievement.

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Old Hats in the Technology Gap

The Integration of Technologies. LESLIE HOLLIDAY, Ed. Hutchinson, London, 1966. 167 pp., illus. 30s.

If there is such a thing as a "technology gap" between Britain and the United States, this book helps explain (unintentionally) why such a gap might exist. Nearly every chapter provides evidence of the backwardness of British technological education and practice as compared with American, of British social attitudes which militate against the exploitation of a scientific technology, and of a tendency to follow behind American leadership in new methodologies and in approaches to scientific-technological problems.

The occasion for this volume is an essay competition, sponsored by Shell Chemical Company in collaboration with the British Association for the Advancement of Science, on the central theme of linking individual technologies together to provide a common body of theory and techniques which might be applied to diverse industrial problems. The essay contest was instituted in 1965, to run for seven years, and the book presents a selection of the entries already submitted, plus several other essays bearing on the same theme. The hope of the sponsors is that publication of these examples will stimulate interest in the problem of the integration of technologies.

None of the authors represented in this collection doubts that there is a problem, namely, that the various technologies have become too specialized and that this overspecialization is preventing technological progress. The basic assumption of the essay contest is that the narrow specialization of the technologies must be overcome by searching for some common threads among them. The only essayist who deals with this basic assumption is Stephen Toulmin, whose stimulating essay "Science and our intellectual tradition" attempts to trace historically the trends toward specialization and the more recent trends toward re-integration of the sciences. Although he does not frame his argument in terms which are relevant to the essay contest, he does raise questions regarding the nature of our scientific knowledge and its technological application. He claims that the change from Athenian (speculative) to Alexandrian (technological) emphases in science involved a failure of intellectual nerve, which prevented Greek science from becoming modern science until "Ionian confidence" was revived in the 17th century. This begs the question of whether the Athenians could have gone farther on pure speculation, and it denigrates what most historians regard as the great achievements of Greek science which occurred during the Hellenistic period. Is it really true, as he asserts, that the mainspring of scientific progress has been philosophical? And if this is so, why does he downgrade our contemporary space science? Insofar as it is a scientific rather than a political or military effort, it has its *raison d'être* in attempting to answer those major questions to which Toulmin thinks all science should address itself.

Most of the 15 essays are written by engineers, and they show the inferiority complex which British engineers feel before "pure" scientists and humanists. There is almost a whining quality about their essays, which deplore the snobbish attitude of the scientists and humanists toward the technologist, the lack of support for technological education in Britain, and the inability of engineers to make themselves effectively heard in Britain. The solutions offered for these problems and for the overspecialization of technologies are likely to seem truisms or naive or "old hat" to most American scientists and engineers.

More than one author points out the importance of education in integrating the technologies. What kind of education? One in engineering fundamentals, which resembles closely the engineering science curriculum introduced in many leading American institutions of technology almost a decade ago.

To some of the essayists, it is the communications problem that is foremost. Alex L. Marshall (Chapter 7) stresses the need for simplicity of language to allow communication between technologies, and his positive suggestion is a technological newspaper—"A bulletin which is easily assimilated . . . no article longer than 500 words, journalese, headlines even" (a technological *Reader's Digest* perhaps?). Edward Manougian (chapter 10) pleads for a common language for the technologies, and, not surprisingly, he finds this in what is already a common language for scientists and technologists, namely, mathematics.

Leslie Walter Boxer (chapter 3) calls for a team approach, but he is contradicted by Alfred M. Prince (chapter 8), who calls for "hybrid vigour": instead of having individuals from different disciplines working together, Prince feels that it is better to have different disciplines within one individual. His concrete proposal is to give fellowships to outstanding individuals within certain disciplines to enable them to get training in a second or third discipline.

There is also the call for new methodologies to achieve the integration of technologies. The enthusiasm of D. M. Jamieson (chapter 9) for general systems research is equaled by the enthusiasm of Arnold Reisman (chapter 13) for operations research, which he claims can be useful in solving all technological problems. Reisman provides a model taken from his doctoral dissertation, which is now in the process of being refined; as presented in his model, operations research seems a barrier to integration rather than a means for achieving it.

The two most meaningful essays, for they cite specific cases where integration has already been achieved in certain technologies, are those by Leslie Holliday, director of the Carrington Plastics Laboratory, and John Hearle of Manchester University. Both their chapters deal with concrete advances made in materials sciences. Perhaps the clue to the integration of the technologies is that it must emerge from the technological developments themselves rather than be imposed artificially or mechanically.

Where does the evidence for the technology gap show in all this? It shows in the fact that virtually all the recommendations, presumably new or at least not fully tried and developed in Britain, are already fairly well established in the United States. And it is

interesting to note that nearly all those essayists who advocate positive measures have studied or taught in the United States at one time or another. Since even the most advanced ideas projected in this book are about a decade behind American theory and practice, we can assume that by the time they are instituted in Britain, America will have advanced beyond them to new concepts and practices, so that the technology gap will still be there and perhaps be even wider by then.

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Reform and Opposition

Drug Adulteration. Detection and Control in Nineteenth-Century Britain. ERNST W. STIEB, with the collaboration of Glenn Sonnedecker. University of Wisconsin Press, Madison, 1966. 351 pp., illus. $7.50.

Drug adulteration is difficult to define, detect, and control. Its definition and detection are dependent upon the state of scientific knowledge and instrumentation of an era. Its control necessitates effective regulatory laws plus extensive changes in social thought and institutions. Because of these complexities, the muckraker or reformer may point to the evils of drug adulteration and yet fail to remedy the situation he deplores. This was the case with the celebrated Frederick Accum, whose *Treatise on Adulterations* (1820) is often cited as a landmark in the campaign for pure foods and drugs. Accum's fight against adulteration in England was renewed in the 1850's by a triumvirate consisting of Arthur Hill Hassall, Thomas Wakley, and John Postgate. Hassall, "the greatest single figure in the English movement for pure foods and drugs," was a skilled microscopist specializing in the microscopic structure of foods, drugs, and their adulterants; Wakley was the crusading editor of *Lancet*; and Postgate, a member of the medical profession, was instrumental in bringing the adulteration question before Parliament. The agitation of these three resulted in the food Adulteration Act of 1860 and opened the way for the more effective and inclusive legislation enacted in the 1870's and 1890's.

Reformers and legislation are but one facet of the problem of drug adulteration in 19th-century England. The state of the chemical and pharmaceutical sciences was of crucial importance, and the authors rightly devote one-third of their book to the new theories, analytical techniques, and instruments that were eventually made available for the detection of adulteration. These innovations in science and technology had to be disseminated among the pharmacists and public drug analysts before they could become effective at the consumer level. Further complications arise when one realizes that all of this ultimately centers upon individual pharmacists who were protective of their professional prerogatives and anxious to maintain a profitable business.

Even this short summary indicates that many separate strands must be woven into the narrative if we are to see the problem of the detection and control of drug adulteration in its historical setting. Stieb and Sonnedecker have been successful in presenting a clear account of the diverse events and influences relevant to their topic; they fail, however, when they attempt to explain why the battle against drug adulteration lasted for over three-quarters of a century. Throughout the book they assume that the English government was motivated by a pronounced laissez-faire attitude toward trade and commerce and that it was this attitude that hampered any move toward state intervention and state control. Their reliance upon the myth of an all-pervasive laissez-faire doctrine as an explanatory mechanism reveals that they are not acquainted with major studies

An early test of the purity of a drug. In this illustration from a medieval manuscript the man on the right is holding a sample of roll sulfur to his ear to detect the crackling sound that will be produced, if the sample is pure, as a result of the warmth of his hand. [Reproduced in *Drug Adulteration*, from the original in the Bayerische Staatsbibliothek, Munich]