

further business of progress, in some of our steepest histograms. Also much invention work has in the last generation or so come to be organized and counted in R&D departments, that was formerly performed by executives and members of the production staff, without separate accounting.

[89] All our indices except those for engineering include a considerable element of scientific discovery in physics and chemistry, and not just invention. Such discoveries inevitably lead to invention, but not at once nor necessarily in the same country. Physical science discovery, which has never been patentable, was a realm in which America had little share in 1880, but an increasing part since, as reflected in the rising share of American papers in the chemical⁶⁷ and physical abstracts,⁶⁸ as per our citational notes. What original science America produced in our early age was wisely confined mostly to the descriptive sciences and medicine, not those forming the direct base for invention. For novel physical and chemical discoveries on which to contrive inventions we depended chiefly on Europe then;¹⁰⁷ but today the exchange is nearer even. We may see that our output in physics and chemistry rose from almost nothing in 1880, to 30 and 20% of the world's indexed publication in 1961, and higher somewhat earlier. We have given before (§ 54) some measure of the relative rise of America in general invention and discovery.

[90] Surveying our graphs for clues, we observe first that all the indices of Chemistry, both pure and applied, are strongly climbing. This science is well known to be in the ascendant, so we may leave it for some observations a little later (§ 105). Physical abstracts have a milder slope, and engineering abstracts and the few in electrical engineering lag yet more. The indices of modern laboratory expenditures in stable dollars are the steepest of all. We may perhaps see a pattern in all this activity, for modern work outside chemistry, to wit that the indices showing the *least* rise are those which especially reflect invention rather than science, or science rather than invention, while those evincing the abruptest modern upsurge are those joining both science and invention. One might say again that invention is old and science is old, but scientific inventing *in laboratories* by scientific men is a new thing on the face of the earth, and hence capable of multiplying itself 345-fold and more yet. But this is not just patentable inventing, nor invention without qualification, which we should most like to measure and compare with the patenting score; but our scientific inventing has become most of it, partly because it includes most of chemical activity. Schmookler's statistics indicate that about three-fourths of currently patented inventions come from scientifically trained men, with a great rise since 1900, and the same proportion from men who have invention as part of their business. (See ftN 99, p. 31.)

[91] All the criteria of our indices represent best the top level, most literate and scientific fields of invention and physico-chemical research; and these would naturally have been expanding faster than the humbler levels of old-fashioned inventing, say of gadgets by ingenious technicians. The upper level is certainly the more important one for today and the future, but not so much more important in the 1880's. Taking an extreme example from farther back, in 1813-41 the whole navigation of the Mississippi valley was largely created by the inventions of a great hero of American history, Henry M. Shreve,