would have predicted, students opted for many of these programs. But, these changes only ratified a trend effected by Massachusetts educators.

Community college critics have offered a similar historical schema for a generation. *The Diverted Dream* differs in its depth and in its emphasis on educators and educational administrators in this transformation.

The scenario it presents, however, may oversimplify a complex set of circumstances. Community colleges may *appear* to be diversionary when related to four-year colleges, but they should be related to other types of academic institutions as well. The comprehensive community college is modeled on the comprehensive high school, but the relationship between these institutions, which often share facilities, goes largely unexplored by Brint and Karabel. The authors briefly note that transfer is not exclusively associated with liberal arts programs. But they do not analyze the current confrontations between vocationalists and accrediting associations over the transferability of vocational work completed in the community colleges.

Also unexplored are the relationships between public and private two-year colleges and between the vocational programs of community colleges and proprietary institutions, including "for-profit" and correspondence schools. An associate's degree from a community college today usually requires that 25 percent of a student's instruction be in liberal arts or general education. Most proprietary institutions have no similar requirement. And students may use many federal grants and loans at either community colleges or proprietaries. Does the growth in community college enrollments come from "diverted" students, from an enlarged student pool from which other educational institutions also draw, or from some combination? Even when noted, these complexities are rarely integrated into the book's interpretative framework.

Are students who plan to transfer actually "diverted" again within the community colleges? The authors cite evidence that students who attend two-year colleges have less chance of obtaining a baccalaureate than students of equal ability who begin at a four-year college, but they are vague on the relative importance of ability and intentional diversion. "To some degree, the arrival in the community college of new, lower scoring students may have played a role in the gradual increase of vocational enrollments," they say. "But the policies of most junior college officials to channel enrollments away from the academic track may have been equally important" (p. 99).

Large numbers of students who say they wish to transfer to four-year colleges never do so. But many of them may drop out entirely, rather than shift to a vocational track. As for guidance mechanisms, "student development" as a field officially emphasizes the fulfillment of student potential, rather than diversion—and many community college students actually receive little guidance of any kind.

Do the community colleges fail in their egalitarian purposes more broadly? The occupations for which they educate may offer less status and remuneration, but may still offer upward mobility to specific students. Indeed, Brint and Karabel say that community colleges may provide "at least short-term upward mobility," though at a long-term cost. Though *The Diverted Dream* identifies other functions of two-year colleges, including developmental (remedial) and non-credit adult education, the authors do not analyze the motivation and the enrollment patterns of the adults who often constitute a majority of community college enrollments.

Brint and Karabel note a renewed interest in liberal arts–transfer programs. They record that black educators have objected to the vocationalization of community colleges since the 1960s. But the book does not delineate how concerns about declining numbers of minority students at four-year colleges led to a "rediscovery" of liberal arts transfer. It might be more correct to conclude that individual community colleges oscillate between several missions rather than shift linearly from one to another.

The Diverted Dream offers important hypotheses about the functions of community colleges. The book offers some grounds for optimism, even if future accounts vote the colleges guilty as charged. For if educators could bring about the current condition of the community college, their successors may have the ability to lead a counter-reformation.

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Cosmic Ray Days

Moments in the Life of a Scientist. BRUNO ROSSI. Cambridge University Press, New York, 1990. xvi, 181 pp., illus., + plates. $44.50.

Bruno Rossi had been one of the pioneers in and major contributors to cosmic physics, starting in the 1920s in Florence and continuing through to his retirement from the Massachusetts Institute of Technology. Now he has given us his scientific memoirs, and, as might have been expected, they are modest and gracious. This is not a comprehensive history, but rather a personal retelling of an odyssey such as was experienced by many of a generation of European scientists who, after uprooting, were able to resume their careers in their new countries, often with great distinction. Recognition for Rossi has come in many ways, most recently through the establishment of an annual Rossi Prize, awarded by the High Energy Astrophysics Division of the American Astronomical Society.

It was a 1929 paper by Bothe and Kolhörster that drew Rossi to cosmic ray research. He greatly improved the efficiency of their coincidence telescope composed of Geiger-Müller counters when he devised what is still known as the Rossi circuit, and he then made good use of this in the exploration of the puzzling properties of the cosmic rays. The complexity of the phenomena could not be fully understood until the discovery of the pions (charged and neutral) between 1947 and 1950, but Rossi played a leading role in several important advances before war intervened in 1939. He calculated the effects of the earth's magnetic field on incoming cosmic ray particles and investigated the differences between the soft and the penetrating components. He predicted the east-west asymmetry in the frequency of arrival of cosmic ray particles and was one of the first to observe this effect. The importance of this observation lay in its demonstration that most of the primary particles had to be positively charged, and thus had to be nuclei rather than electrons.

During these prewar years, Rossi was indirectly responsible for another major discovery through sending his younger colleague Occhialini to Cambridge to work with Blackett. At that time there was no cloud-chamber expertise in Italy, and Rossi wanted Occhialini to learn the technique from what was then the premier group. Occhialini brought with him Rossi's coincidence telescope system; when combined with Blackett's cloud chamber, the result was the discovery in 1933 of the cosmic ray production of electron-positron pairs, in confirmation of Dirac's still-new theory. (Only a short time before, Carl Anderson at Caltech had discovered the positrons but not the pair production.)

Rossi describes his journey from student days at the Universities of Padua and Bologna, to his first faculty position in Florence, then, with some regrets, to the chair in Padua, where he guided the design for the new Istituto di Fisica, only a short walk from the Scrovegni Chapel with its frescoes by Giotto. Ousted from his position in Padua as a result of Mussolini's anti-Semitic

laws, Rossi had brief stops in Copenhagen, Manchester, and Chicago before taking up a position at Cornell. Soon after his arrival in the United States, he made the first determination of the lifetime of the muon (mesotron, in those days).

As with many European émigré scientists, there was an interlude for Rossi in Los Alamos, where his coincidence circuitry again proved useful, but it is clear that he was glad to return to academic life, to a position at M.I.T., where he was able to resume his cosmic ray work. His cloud chamber group was one of the leaders during the 1945–55 period, when much of the attention of cosmic ray workers was directed to studying the interactions of the cosmic ray particles and elucidating the properties of the newly discovered V-particles. A natural extension was the investigation of the highest-energy particles and their interactions, through the extensive air showers they produce. Then, a few years later, Rossi went into space physics, with a plasma probe on Explorer 10. Still one more area was opened up when Rossi, with colleagues in American Science & Engineering, a small company he had helped found, discovered the first nonsolar x-ray sources during a rocket flight.

Rossi's influence has been widely felt. The names of his associates that flow through these pages are in themselves an impressive testimonial. Rossi makes modest mention of his books—on high-energy particles, optics, and cosmic rays—but his clarity of exposition is well known. His 1941 review paper with Greissen stood as a bible of high-energy particles until the appearance of his book on the subject, which still, after nearly 40 years, has one of the best introductions to the electromagnetic interactions. From his similarly brief mention of the International Cosmic Ray Conference at Bagneres-de-Bigorre in 1953, one would not guess that his review presented at the closing session was one of the conference highlights, bringing clarity to a truly confused situation in particle physics.

We are fortunate to have these reminiscences, for they describe a time that now seems far gone, an age of innocence (as Rossi aptly terms it) before particle physics was taken over by the accelerators and before space physics had grown to its present proportions. If I have a regret after reading this book, it is that it is too short. It would have been good to have more of Rossi's recollections of the departments where he worked, of the people there, of the selection process for university chairs. There are glimpses—vignettes of Bologna, Padua, and Florence—that remind me of Born's memoirs, evoking a very different time, a different pace of research. There is a charming postscript from Nora Rossi. In all, this is a fascinating document, not only for those of us who have also worked with cosmic rays but for everyone with an interest in the history of 20th-century physics.

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Kinetostatics

Freedom in Machinery. Vol. 2, Screw Theory Exemplified. JACK PHILLIPS. Cambridge University Press, New York, 1990. xiv, 251 pp., illus. $85.

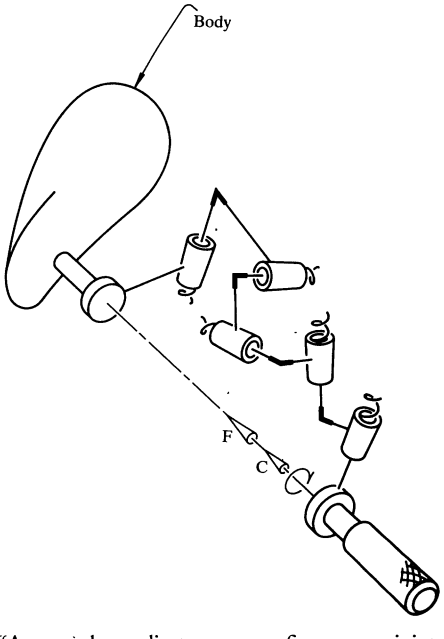
The treatise "Screw Theory Exemplified" completes a two-volume work that stands uniquely as an authoritative account of the subject of screw theory. In these volumes, Phillips manages to do what no other seems to have done before him—that is, excite and inspire the reader's imagination about mechanisms. He convinces the reader that it is possible to visualize the freedoms and constraints of a general mechanism, and he does this in a way that is unrestricted and unhindered by algebra. The theories that he painstakingly proves are synthetic in nature, apparently presented with the intention of establishing in the reader a new thought process—one that is based upon the pure geometry of the mechanism itself and not upon an algebraic manipulation of the vector quantities that numerically describe it. After all, readers can write down their own equations, which become more meaningful and more useful as their understanding of geometry evolves.

The first volume of the work, "Introducing Screw Theory," which was published in 1984, proceeds in the simplest possible way, investigating the contact of two bodies in a single point. Phillips brings to life such examples, delineating them spectacularly to instill in the reader a sense of how an interactive force can be transmitted in the general case along a normal line of contact. Tangential to a given normal line of contact exist the possible routes of relative travel of points in the two bodies. Phillips illustrates these motion capabilities and concurrently begins the groundwork for the theory of freedom and constraint in machinery.

Volume 2 picks up where volume 1 left off, illustrating the properties of line systems and concentrating on the importance of the line in kinematics and statics. Phillips further investigates, in a sophisticated way, the path routes of points in neighboring bodies and the forces that interact between them. This development is a prelude to the final unveiling of the notion of reciprocity, which is the crux of all freedom and constraint found in machinery.

Much of the theory contained in these volumes has already been established, and Phillips recognizes this by accurately citing the earlier literature. Throughout the work, it is his intention to couch established theory in a more manageable form so that the beauty of the pure geometry can be appreciated and, once understood, be applied. This is the case especially with the cylindroid. Phillips mentions the cylindroid on numerous occasions in volume 1, but not until volume 2 does he bring it to life in mechanisms. He strives effectively to convince the reader that the cylindroid is "ubiquitous in mechanism" and that the reader "may effectively cope with it and its ramifications."

In a chapter entitled "Fundamental relations and some algebraic methods," Phillips investigates various ways in which screws, vectors, and pairs of vectors can be located with coordinates. On this subject he uncovers deep-rooted seeds in our minds, causing us to ponder What are vectors anyway? He summons the established work of Brand to explain the helicoidal property of pairs of vectors, which is the requirement that two vectors (a motor) describe a twist or a wrench. Continuing on this subject, he quotes the historic works of Clifford, Keler,



"A wrench applicator across five screw joints which is almost certainly unstable. The joints are merely arranged as members of a 5-system of motion screws whose reciprocal 1-system is the required wrench. If the screw joints were all simply hinges, namely screw joints of zero pitch, the hinge axes would belong to the same linear complex whose pitch would be the pitch of the wrench." [From *Freedom in Machinery,* vol. 2]