time, Mr. Lanchester, working from first principles, developed the same conditions for the production of longitudinal stability. Both investigations are dependent for numerical data on the results of experimental research on models, and in producing this the aerodynamical laboratories are concerned. In England such data are produced at the National Physical Laboratory, whilst France, Germany, Italy, and Russia have each one or more institutions for the purpose of aeronautical experiment.

Finally, there are the constructors and pilots who apply the results to practice. In the case of the RE 1 the application was made by the Royal Aircraft Factory, the pilot being responsible, not only for the flying of the machine, but also for the adjustments necessary to produce the desired amount of stability.

The mathematical analysis, most clearly expressed in Prof. Bryan's work on "Stability in Aviation," has shown that for all aeroplanes the motion may be considered as dependent on four surfaces. The surfaces need not have any exact material existence in the aeroplane but are equivalent to the sum of the effects of all the separate parts. The position of these surfaces can be described quite shortly; the largest of them carries practically the whole weight of the aeroplane, and in a monoplane is almost identical with the main planes. A second surface roughly parallel to the supporting surface and behind it is used to obtain longitudinal stability, whilst two vertical surfaces, one above and the other behind the main supporting surface, are necessary to produce lateral stability. The equivalent surface above the main planes is usually produced by turning up the wings near the body so as to make a dihedral angle, whilst that behind the main planes is in large part provided by the rudder and fixed tail fin.

Each of these equivalent surfaces is somewhat complex in character, and in particular the rear vertical fin is dependent on whether the propeller is running or stationary. Theoretical considerations indicate that any good flying machine can, however, be made stable by suitable choice of these four equivalent surfaces without affecting appreciably the design of the aeroplane from the point of view of efficiency and strength. Actual flight has shown how in one particular case, at least, it has been done.

The problem of flight, however, is more difficult than that of producing stability, and further analysis brings into prominence the importance of knowing the amount of stability. In the course of the Wilbur Wright memorial lecture, Dr. Glazebrook exhibited diagrams which, amongst other things, showed the amount of the rise and fall of a stable aeroplane in a moderate wind, this rise and fall being necessary for recovery from disturbance. As a deduction from these diagrams it appears that in really rough weather a stable aeroplane might be tossed about to an uncomfortable extent. The analysis which leads to this result also indicates a remedy, and by an extension it is possible to investigate the effect of moving the controls of an aeroplane and so to utilise the result as to produce a mechanical device for reducing the tossing. It is perhaps unwise to attempt to prophesy, but it appears to be probable that the aeroplane of the future will be inherently stable, with a degree of stability now thought undesirable, and that it will be provided with a mechanical device for operating the controls so as to reduce the effect of an external disturbance. Near the ground the pilot will always need to take control, for then the manœuvres may require to be quite different from those natural to the flying machine.

Problems of an urgent but entirely different character are also presenting themselves to the constructor for solution. A suitable engine is still being sought for, whilst the problem of safe alighting is probably the one now presenting the greatest number of difficulties.

TECHNICAL EDUCATION FOR FISHERMEN.

WE noticed, a short time ago (May 28, p. 324), the report of the Departmental Committee on Inshore Fisheries, but did not deal fully with the sections relating to education. Some of the recommendations made in the Report are most useful in so far as they direct public attention to the question of the better education of fishermen. We feel, however, that they do not suggest any useful advance upon what is already being done by certain local authorities under the stimulus of the Board of Education; and it is evident that the committee, in their desire to report speedily upon the other more important questions referred to them, did not fully acquaint themselves with the real conditions at the fishing ports so far as the instruction of fishermen is concerned.

Two distinct questions are involved: (1) that of the better education of the deep-sea men, and (2) that of the education of the inshore men.

(1) *The Deep-sea Fishermen.*—Until a few years ago it seemed as if the craft of the fisherman were almost the only one for which technical instruction was unnecessary. For centuries the methods of trawling, drifting, and lining have been carried on with essentially no modification. But with the development of the modern deep-sea fishing vessel, and the enormous industrial change which has followed this, there arose the necessity for a real knowledge of working methods of navigation. Even for such vessels working in the shallow seas a sound acquaintance with the rule of the road was necessary; and when steam-trawling became extended to Icelandic waters, the Barentz Sea, and the coast of Morocco, it became evident that there was little in the way of a knowledge of navigation, as it is practised aboard a transatlantic liner, that was not also required by the master of a steam-fishing vessel. Repeated and lamentable losses of life and property, experienced even during the last few months, have driven home this truth in the minds both of owners of fishing vessels and of

Board of Trade officials, so that the standard of proficiency expected from candidates for fishing certificates is now rapidly approximating towards that expected from foreign-going merchant service officers. This is as it should be, and under the stimulus of the increasing stringency of the Board of Trade examinations, and the active oversight of the Board of Education, fishery navigation schools are successfully being worked at Fleetwood and Piel, Grimsby, Hull, and other places. So much for the purely professional training of the fishermen, but with that desire to be "practical" which so appeals to the local administrators of public money, such handicrafts as seamanship, net-making and mending, engineering, knot-making, splicing, and cookery are also taught, with, we fear, indifferent success.

Nowhere in England, except at the Lancashire Sea-Fisheries Committee's Laboratory at Piel, Barrow-in-Furness, has marine biology and oceanography been taught. Usually instruction in those subjects has taken the form of public lectures given at the fishing ports, and no one who has had personal experience of this method of education can claim that it is even moderately successful. Systematised instruction in marine biology, so far as it relates to marine economic animals, was instituted in Lancashire in 1900, and has been continued in a gradually modified form ever since then. Personal laboratory work is done by the men, and the usual methods of instruction by means of lectures and demonstrations are also carried on in a very thoroughly equipped marine biological station. Scholarships are awarded by the county education committee to men who indicate their fitness for the instruction, and each fisherman student spends a fortnight at Piel, working from five and a half to nine hours a day for a fortnight. At the present time the instruction includes marine biology, seamanship, oceanography, and navigation. It is intensive and systematised, and has been successful to an extent indicated by the ease with which the men selected have obtained Board of Trade certificates; by the disappearance of the hostility with which the early attempts at fishery regulation were met; by the applications of scientific principles which have been made by the fishermen themselves in some localities; and by the ready cooperation of the men in the work of fishery investigation—in obtaining statistical data, for example.

Apart from such systematised instruction, deep-sea men can only educate themselves by infrequent, and mostly evening, attendance at the navigation schools, or at occasional fishery lectures. In itself this is an unsatisfactory method of instruction, and one which demands considerable expenditure of money, and of the very limited leisure time enjoyed ashore by these fishermen. But an equally serious difficulty is the defective elementary education of the men. At the present time a boy cannot go to sea in a deep-sea vessel until he is sixteen years of age, or unless he is apprenticed—a system of employment which is disappearing in most ports. He leaves school at fourteen, and the two years' interval is often spent in undesirable forms of shore employment, or in some form of inshore, or shore, fishing; and during this time what little primary education he did acquire mostly lapses. It is in these years, and during the first year or two of life at sea, that the education of fisher lads must be organised. It is not asking too much from the employers, during this period of a fisher-boy's life, that they should be made to send him to school on full or modified pay for, say, two or three months in the year to receive continuous and systematised instruction. It *is* asking too much from the lad, or from his parents, that he should either obtain his education by attending evening school after a long day's work, or by sacrificing a considerable fraction of his earnings. If the technical education of the fishermen is greatly to be improved this sacrifice should be expected from the employers of lads.

(2) *The Inshore Fishermen.*—It will probably be found impossible in actual practice to set up different systems of technical education for lads likely to become inshore or offshore fishermen. To begin with, it is clear that what a boy will become when he attains the age of sixteen depends on "chance," on temperament, or on opportunity. Some knowledge of the conditions on part of our coast convinces us that it is generally the lad who becomes "shiftless," either from temperament or example, or he who is naturally impatient of discipline or routine, or he whose parents desire to make the most of him regardless of his future, that swells the numbers of inshore fishermen, mussellers, cocklers, shrimpers, etc. It is all work that a strong boy, brought up by the seaside, can do almost as well as a man; work at which he can earn much more than he could at a skilled trade or in deep-sea boats—generally where a superior technique is required. A lad of this class who is ambitious and has received a tolerably good primary education will go to sea, not as an inshore fisherman, but either as a deep-sea fisherman, or in the merchant service. So far, then, as a primary education for a seaboard population can be specialised it should become one which includes simple science—marine biology and oceanography—if these matters can be taught at primary schools without prejudice to a plain elementary education without imperfectly taught fads.

The organisation of the continuation education—that which we suggest should be given, not in evening classes, but continuously as a fisher-lad's daily work throughout some part of the year—presents the greatest difficulty. There is no difficulty with respect to what ought to be taught the lad who is going to sea in deep-sea fishing vessels: what he must learn is still the "three R's," and such things as nautical astronomy, trigonometry, marine architecture, and magnetism. But are we really going to help our inshore fishing population by attempting to teach the boys "ropework, sail-mending, signalling, carpentry, and metalwork," "practical courses on marine motors and their installation, net-mending and the preservation and curing of fish," and "business methods" all in continuation evening classes? Surely these are not school subjects, but handicrafts, and surely the attempt to teach them in schools is merely overloading a primary education already burdened by sufficient imperfectly taught "subjects." If these things are to be really useful they must be acquired by a boy in the daily practice of his occupation.

If scientific instruction can be given in addition to the above, so much the better, say the inshore committee. It is proposed that this instruction be given by "occasional lectures." These would explain "the most up-to-date methods as well as the cogency of the case for any newly imposed by-laws." They would "obviate any resentment felt for ordinances" and "convince fishermen of their expediency." Would they? The experience of the Lancashire local committee, which first in England attempted to regulate, by restrictions, a large inshore fishing population was that any attempt to argue for (or explain) by-laws by means of public lecture was fatal at once. But simply to impart, by means of sound laboratory instruction, the main things in the life-histories of marine economic animals—that is, by pure scientific instruction—has gradually effaced the intense hostility to legislative interference which those who began fishery regulation in England experienced. This end has to be attained *indirectly*. It is like the much-discussed question of sex-hygiene instruction. Why not plainly teach human physiology? And must one still apologise in England when he wishes to impart a scientific education?

Certainly methods of preservation, curing, marketing, etc., ought to be described in lectures and informal conferences; certainly methods of fishing in use abroad or in other parts of the country should be demonstrated; certainly the choice and upkeep of motor installations should be the subject of informal meetings and conversations, all these things being described to inshore fishermen by "practical" men or tradespeople. But this is rather organising the industry than educating the fishermen.

J. J.

SECULAR CLIMATIC CHANGES IN AMERICA.[1]

NEITHER the meteorologist nor the geologist commonly realises the extent and importance of the changes which have taken place during the "historic period." The latter is apt to close his investigations with the Ice Age; the former too often concerns himself only with the period of instrumental observations. The intervening "post-Glacial" time is the field of relatively few workers, who are rapidly building up the new science of "Palæoclimatology."

Prof. Huntington's elaborate memoir on the "Climatic Factor" should do much to gain recognition for at least the later stages of this period. From the viewpoint of the "pulsation" theory of climates developed during similar investigations in arid Asia, the author studies the climates and their attendant effects during the last thirty-five centuries over an area extending from California to Guatemala. A study of the ruins of arid New Mexico shows that at three distinct periods prior to the coming of the Spaniards the country was able to support a far greater population than can exist at present; this could only have been possible with a heavier rainfall, permitting the cultivation of regions now too dry for agriculture. The strand lines and gypsum dunes of the Otero Soda Lake and the alluvial terraces of the rivers point to the same conclusion (though the theory that even in rivers reaching the sea terraces and deltas are the result of changes of climate rather than of level will come as a shock to most English geologists).

In America there are no continuous historical records from which the ruins can be dated; this deficiency is supplied in an unexpected way by the measurement of the rings of growth of the giant Sequoias of California, some of which are more than three thousand years old. By means of an empirical formula, Prof. Douglass, in a chapter on a method of estimating rainfall by the growth of trees, has been able to reconstruct the rainfall, for the period over which records exist, with an accuracy of 82 per cent. With the very old trees, however, a number of corrections are necessary, which render uncertain the slope of the curve plotted from the measurements, although they do not impair the evidence of short-period fluctuations. The corrected curve shows cycles of 155 years, of 21·0 years, and of 11·4 years, and in addition three long wet periods, from 1000 B.C. to 300 A.D., from 900 to 1100 A.D., and from 1300 to 1400 A.D., which Prof. Huntington considers must correspond to the three native civilisations of New Mexico.

This curve is next compared with the curve previously published in "Palestine and its Transformations," showing the fluctuations of climate in arid Asia. There is a pronounced agreement between the two curves, especially during the period from 300 to 1000 A.D.

The Maya civilisations of Yucatan and Central America are next investigated—though, since these regions largely suffer from an excess of precipitation, they can scarcely be included in "*arid*" America—and the theory is developed that these extinct civilisations fell in dry, cool periods contemporaneous with the moist periods of New Mexico, both changes being the result of a southward movement of the subtropical anticyclone. The coolness stimulated the Mayan races into activity, and the dryness enabled them to master the forest. The dates of the Maya chronology are not yet satisfactorily worked out, but so far as they go they confirm this correlation. An attempt is made to connect the terrestrial changes with changes of the sun's surface, but the results, which are illustrated by curves, do not appear to

[1] "The Climatic Factor as Illustrated in Arid America." By Ellsworth Huntington, with contributions by Charles Schuchert, Andrew E. Douglass, and Charles J. Kullmer. Publication of the Carnegie Institution of Washington, No. 192. Pp. v+341. (1914.)