transport equations which requires a judicious combination of ingenuity, intuition and inspiration for closure. Experiments on heat transfer from single tubes and tube banks in cross flow are described by A. Zhukauskas. Various geometries, and parameter ranges of $0{\cdot}7 < Pr < 500$ and $1 < Re < 2 \times 10^6$ were studied. The remaining papers report on experimental techniques: E. A. Brun describes a number of methods for measuring concentration and hence mass transfer rates in a boundary layer; M. Barat examines the influence of turbulence on pressure measurement; T. J. Hanratty discusses electrochemical techniques used to measure local mass transfer rates and local wall velocity gradients; R. J. Goldstein describes the laser-Doppler method of velocity measurement; and A. M. Trohan reviews several optical methods for the study of turbulence.

The other contributions to the seminar are described (often very cryptically) only by their abstracts. About a third of them are concerned with experimental techniques. The remainder treat such diverse topics as cavities of one sort or another, impinging jets and wall jets, roughness elements, cylinders and other bodies in cross flow, steps, channels and discs.

The books are very poorly produced: Trohan's paper ends in mid-sentence, several pages are so faint as to be almost unreadable, and there is a very large number of irritating mis-prints. (Spelling mistakes are detectable—but how many misprints have also occurred in the equations and numerical constants, which are not so readily identified?) The delay in publication is greatly to be deplored: much of the work is now out of date. Future volumes in this series have considerable scope for improvement. Nevertheless, these books should obviously find their way into research libraries.

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E. F. Adiutori, **The New Heat Transfer.** Ventuno Press, Cincinnati (1974); (Unpriced).

The author's claims are not modest. He believes he is initiating not only a new heat transfer, but also a new engineering. According to him, in 120 years time, the laws of Hooke, Newton, Ohm, Fourier, Stefan-Boltzmann, will have vanished, coefficients of heat-transfer, thermal conductivity, electrical resistance, elastic moduli, drag and lift, will all have disappeared, and there will be no more dimensional analysis. "In their place will be simple non-linear concepts—providing the foundation for a simple logical science of engineering which will transform presently impossible problems into simple exercises!" Of course these predictions as such do not constitute claims. Adiutori's claims consist in saying that such major revolutions are all made possible by his new proposals and will inevitably grow from them. Now it would be a very rash man who would insist that the conceptual structure of engineering science will not change in 120 years and it is possible that some of the changes may be in the direction predicted. But I do not think it is at all rash to say that if this does indeed occur, it will not be on the "foundation" provided by Adiutori.

For, let us consider what this proposed new method actually is. Given that we observe a thermal flux rate $\dot{Q}$ and a temperature difference ΔT we can assume a general functional relation of the form

$$\dot{Q} = \dot{Q}(\Delta T, x_1, x_2 \ldots x_i) \tag{1}$$

where the x's are any other variables which may be relevant. We can also consider a relation

$$h = \frac{\dot{Q}}{\Delta T} = h(\Delta T, x_1, x_2 \ldots x_i). \tag{2}$$

Similar alternative relations are possible when the variable ΔT is replaced by grad T.

Now the whole of Adiutori's case is based on his statement that we should not consider relations of the type (2) but only relations of type (1). He gives no rationale for this statement, but simply endless repetitions of it in a variety of forms, e.g.: "In the new heat transfer we deal with heat flow and thermal driving force separately and do not permit these two primary and dynamic variables to be confounded in a ratio." "The primary variables are confounded in the old heat transfer and separated in the new." "In the old heat transfer the invention of the h.t.c. promotes the use of confounded variables because the coefficient is itself the result of confounding the primary variables heat flow and thermal driving force." "In the new heat transfer experimental results will be correlated with separated variables and permit equipment to be designed and analysed with separate variables." And so on.

The best that can be said for Adiutori is that he has thought about the meaning of engineering concepts, and particularly heat transfer concepts, somewhat more than many workers who publish results in this field—but that is not saying very much since few think about them at all. Anyone who wants to introduce fundamental innovations in the conceptual pattern of science or engineering—and some innovations may indeed be desirable—has to think much more deeply about the philosophy and methodology of the subject than the author has done. Given his initial idea, and enthusiasm, he should have armed himself with a thorough study of the epistemology of engineering before tackling such an important task. Instead he has approached the matter with a complete naivete, and nothing in his text shows awareness of even the most elementary methodological principles.

Thus, for example, heat flow rate itself is, to use his terminology, a "confounded" variable, the ratio of a measured energy quantity Q to a time t. If equation (2) is to be proscribed, why should we not also eschew equation (1) and insist on using the form

$$Q = Q(t, \Delta T, x_1, x_2 \ldots .) \tag{3}$$

A list of such naivetes in his views would be merely boring, but there are indeed many. In fact no scientific property, concept, or measurable quantity, has this direct "separated" characteristic which he assumes for some and denies to others. The raw data of pressure measurement for example are levels of liquids in tubes or displacements of diaphragms or rotations of Bourdon tubes, etc. The result which we state as pressure is already a "confounded" variable. So of course are velocity, acceleration, mass flow rate, and indeed everything with which we do our useful thinking.

His step from the "new heat transfer" to the "new engineering" is made by the same naive argument. Elasticity moduli, etc., are to be forbidden. We are to consider only stress and strain, but not their "confounded" ratio. The fact that stress and strain are themselves each "confounded ratios" escapes him. Dimensionless groups and dimensional analysis are forbidden on the same grounds of "confounded" variables, etc. etc.

Faced with this nonsense, there is an obvious temptation to say that the book is not worth the attention of a review in a serious journal—and in a sense that is true. However, just because most workers in the field give little thought to the conceptual methodology of engineering, some may find a specious plausibility in Adiutori's discussion of specific cases. This might very well mislead the unwary as much as it has misled himself. Since most of his specific cases are in film cooling, boiling, condensation, two-phase regimes, thermal instability, and other fields where the present situation is dominated more by a variety of experimental correlations than by theoretical understanding, it is easy for him to show cases where existing correlations in terms of particular dimensionless groups are unconvincing. Accordingly he draws attention to some points which are indeed worth notice and worth re-interpretation. It is such recognition of the value of his questions which may lead the unwary into crediting his answers.

However, quite apart from the fact that his treatment cannot support his fundamentally unsound thesis, he bedevils his presentation by sheer error. Thus for example in Chapter 6, discussing film cooling, he objects to the usual correlation

$$\eta = 21{\cdot}8\left(\frac{hG_s}{xG_m}\right)^{0\cdot8} \tag{4}$$

where h is height of slot, and G_s and G_m are respectively the mass flow rates per unit area of slot and of mainstream. He replaces it by the algebraic identity

$$\eta = 21{\cdot}8\left(\frac{J_s}{xlG_m}\right)^{0\cdot8} \tag{5}$$

where l is the length of slot and J_s is the mass flow rate through the slot, i.e.

$$J_s = hlG_s.$$

He considers (4) fallacious because he says it makes the result appear to depend on the parameters h and G_s/G_m whereas (5) shows that h and G_s/G_m are unimportant, and that what matters is J_s/l. This is of course nonsense. What (4) states is a dependence on G_s/G_m if h is kept constant and a dependence on h if G_s/G_m is kept constant—while (5) states a dependence on G_m if J_s/l is kept constant and on J_s/l if G_m is kept constant.

Similarly I can make the Reynolds number for flow in a circular pipe $(\rho vD/\mu)$, or (GD/μ), or $(4J/\pi D\mu)$ but it would be wrong to say that the first form is fallacious because it makes the result appear to depend on v while the third shows that v is unimportant and what matters is J.

An additional absurdity is that of course his form (5) is still a dimensionless group. Yet on this basis he says: "It is my intent that this Chapter 6 be the death warrant for the old way concepts known as dimensional analysis and dimensionless groups".

I took up the book with pleasurable anticipation, being actively interested in and empathetic towards the problems of innovation in engineering theory. I put it down with disappointment and indeed sadness—depressed to find that someone well versed in the literature and practice of thermal design, and competent enough to raise some valid queries about current procedures, should attempt innovation with such naivete and with such little preparation for the task, and commit such blunders in his attempt.

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