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Book Review

Fundamentals of Heat and Mass Transfer, by Incropera and DeWitt, John Wiley & Sons, 4th edn, 1996
Introduction to Heat Transfer, by Incropera and DeWitt, John Wiley & Sons, 3rd edn, 1996

These new editions of well-known and widely-used textbooks, the second being a slightly-cut-down version of the first, are handsome, well-designed and attractively-printed volumes, of the creation and marketing of which the publishers can be as justifiably proud as the authors evidently (but perhaps with less justification) are of their own handiwork. In their prefaces, the authors call each work "a mature representative of heat transfer pedagogy"; and they go on to explain its "maturation" history.

I did not know that "maturation" was a recognized English word, but it is. The Concise Oxford Dictionary gives "Ripening of morbific material" as its first meaning; and it defines "morbific" as "causing disease"; which conjunction of ideas might bring to mind Ogden Nash's self-doubting lines:

"Do you think my mind is maturing late
Or simply rotted early?"

did not the confident tone of the preface make self-doubt unthinkable.

Had the authors used "maturing" instead, unconscious memories of Keats' "season of mists and mellow fruitfulness, close bosom-friend of the maturing sun" might have pre-disposed me in favour of what followed.

Such are the risks run by authors who prefer the unusual word to the right one!

Books of such size and influence deserve to be reviewed with some solemnity. But how? It is foolish to pass judgement on what topics are included, and what are left out; for the authors' choices have stood the test of time, having been confirmed as what the heat-transfer teaching community desires. One might criticise that community for not demanding more, but not the authors for supplying successfully what was demanded. Nor is it probable, at this stage, that even the most careful reviewer will uncover any major error of fact or argument.

However, since the authors may already be planning further editions, they may welcome suggestions as to the contents of the next questionnaire which they will send out to their 100 advisers; and professors and instructors who are not yet committed to Incropera and DeWitt may be interested in a reviewer's comments on the quality of thought which the text reveals, and in some comparisons with alternatives.

The questionnaire, I suggest, should include the following:

* Do you find our tone at all patronising?
* Do you like being addressed as "you"? And being told at the end of a chapter what "you should" now "know", "understand thoroughly", "be capable of", and "challenge yourself with"?
* What do you think about the first simple rule of our "Methodology for a Convection Calculation", namely: "Become immediately cognizant of the flow geometry. Does the problem involve flow over a flat plate, a sphere or a cylinder?"
* Have you heard any students say that they have been "becoming cognizant" of anything?
* If not, do you tell them that they should?
* And can you think of any other body shape which ought to be mentioned in a rule which we have emphasised as applying to "any flow situation"?
* Which spelling do you prefer: "Reynolds number" or "Reynold's number"? Or shall we continue to use both?
* We have a lot of trouble with the "-ing" ending. One of our readers has said that "substituting from Equations 2.8 and 2.9, we obtain ..." is OK, whereas "substituting from equation 2.7, it follows ..." is not. Can you help us to see the difference, please? Because we use the "-ing" ending many, many times.
* Do you think that we are right to state ("Fundamentals", p. 258) that "calculation of identical temperatures at successive times for the same node is an idiosyncrasy of using the maximum allowable value of Fo ..."? If not, can you suggest a better way of expressing what we were trying to say?

Now for something about the quality of thought.

The final words of "Introduction to Heat Transfer" (in Appendix E) are:

"This result agrees precisely with that obtained from the exact solution, Equation 7.21".

A splendid final flourish, one might say. However, the student who has obeyed assiduously all the "you should"s, might be surprised by that "precisely"; for it comes at the end of an avowedly *approximate* (i.e. Karman–Pohlhausen) analysis of firstly the hydrodynamic boundary layer and secondly the thermal one.

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Now the solution for the former did *not* agree precisely with the exact solution; so why should that for the latter? What has become of the analogy between heat and momentum transfer? And did not the heat-transfer analysis actually incorporate that for the velocity boundary layer?

Unaided by Incropera and DeWitt, the puzzled student will have to seek explanations elsewhere. I turned first to Eckert's *Introduction to the Transfer of Heat and Mass*, McGraw-Hill, 1950; for it was this book which introduced the Karman–Pohlhausen analysis to English-speaking readers (and authors too, I guess).

There, that which Incropera and DeWitt gloss over, with that tell-tale phrase "after some manipulation", is revealed to involve:

* Presuming that both the velocity and the temperature profiles have an identical (cubic-polynomial) form;
* Presuming that the thermal layer is thinner than the hydrodynamic layer;
* Treating 14/13 as near-enough equal to unity; and
* Neglecting the last term in a quartic polynomial.

Eckert is also careful to acknowledge Kroujiline as the originator of the analysis, and to discuss the extent to which its validity depends on the Prandtl number.

Perhaps, I thought, Eckert's respect for his readers' "need-to-know" has fallen out of fashion. I therefore looked in A. F. Mills' *Heat Transfer*, Irwin, 1992. There I found that:

* The analysis is included in the body of the text rather than in an appendix;
* The 3% accuracy of the solution for the hydrodynamic layer is acknowledged as fortuitous, and emphasised by the words: "if a quartic profile is used, the accuracy is less than for a cubic!";
* The assumptions set out by Eckert are given in full (except that 14/13 appears to retain its value; I am not sure how);
* The result is characterised as being merely "almost identical" to the exact solution; and finally
* Mills comments: "This agreement is reassuring, but it is also fortuitous, since our integral method is an approximate one".

So Eckert's scholarly spirit still flourishes at UCLA. May its influence spread further!

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