Preface by Yves Bréchet

Some thoughts on the virtues of exercises and problems...

Blaise Pascal, who knew a lot about persuasion as well as about constructing science knowledge, wrote:

> "*One is usually better persuaded by reasons one has found oneself, than by those that have come into the minds of others.*"

All those who have been involved in teaching know that the aim of a lecture is to make students want to understand, but that it is through the practice of exercises, in a less theatrical relationship, that the student has really understood. That is to say that he has not limited himself to remembering, but that he knows how to reconstruct the reasoning that allows him to appropriate the acquired knowledge of the discipline, the only way to be able to go one step further himself, either in the application or in the enrichment of the knowledge. This shows the importance of "exercises".

Similarly, "problems" get a bad press because they are too often associated with the need to assess a student's learning. This is certainly one of their functions, but in my opinion, it is the least of them: a well-designed problem should allow the student to continue learning, and he should know more when he leaves the exam than he knew when he entered it. Any teacher who sees a problem only as a control tool is condemning himself to a sterile psittacism which, in its most perverse form, ends up shaping the course itself not according to what is useful to know, but according to what is easy to control.

The volume of exercises and problems proposed by Didier Blavette and Thomas Philippe places them firmly in the tradition of Pascal. The theme of the collection presented here, on phase transformations and diffusion, allows for a treatment which, without claiming to be exhaustive, has the merit of being coherent. The alternation of concise and enlightening reminders of the course, and exercises and

problems of varying difficulty, corresponding either to "classics" or to lesser-known results, offers a progression that allows the student to "construct" his own reasons.

The illustrations, often coming from the field of the Atom probe tomography where the Rouen team has taken the lion's share, fulfil this beautiful mission that D. Blavette called "to make visible the invisible" in a distant echo of Jean Perrin who gave himself for the atomic theory "to explain the complicated visible by the simple invisible".

Finally, the structure of the book, in a beautiful classical style, declines three pillars of phase transformations: what are the driving forces that are responsible for them, what are the mechanisms of mobilities that make it operational, what are the kinetics that result from the combination of these two aspects.

Does it need to be said? It is so obvious to all those who work in the "material" industry that it is fascinating that it can be so easily forgotten in high places. However, pedagogy is the art of repetition, and we have too often heard the Trissotins say with aplomb that is matched only by their ignorance, that physical metallurgy was a discipline with no future. It is always necessary to remind them of the obvious, at the risk of offending their certainties, and particularly at a time when "industrial sovereignty" has become a fashionable slogan: metallurgy is the indispensable foundation in many industries of sovereignty. This sovereignty begins with matter and materials, with manufacturing knowledge. The practical implications of the phenomena illustrated here cover immense fields of industrial application, from aircraft fuselage alloys to superalloys for turbines, from ageing materials for nuclear power plants to high-strength steels for automobiles. However, it is also in magnetic memories, in the realization of semiconductor nanostructures, in the development of hard magnets, or in the optimization of stainless steel thermal engine injectors, that we find the importance of phase transformations.

Moreover, in the great movement of materials science towards the "tailor-made material", physical metallurgy, and in particular that of phase transformations, shows an ever-innovative way, and it is by a practice of the exercise and the problem as much as by the lecture, however brilliant it may be, that we will train the engineers and the scientists who will open this way…

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