Subject:
In connection with the introduction of the First Law of Thermodynamics it is often stressed that the internal energy is a state variable. When the entropy is introduced, one also insists that it is a state variable. Recently, the name state variable is also being used in connection with the pressure, particularly in the school book literature.

Deficiencies:
The name state variable was introduced in order to express that a physical quantity in a state has a certain value. However, this is true for all physical quantities, with only two exceptions: work and heat. If one stresses for only a few quantities that they are state variables, the impression results that being a state variable is not the normal case, but the exception. The fact that a quantity in a well-defined state has a certain value is a characteristic which one expects anyway. If one wants to emphasize something, then one should instead stress that there are two quantities, work and heat, which do not correspond to the reasonable expectation.

Origin:
It is somewhat different with internal energy, entropy and pressure.

The first formulation of the conservation of energy appeared in the First Law of Thermodynamics, which related the process variables work and heat to the internal energy. Scientists were happy to point out that the internal energy is a state variable, stressing that one of the terms is a quantity with normal properties. It appeared remarkable that the sum of two non-state variables results in a state variable.

Now to the entropy. Since the beginnings of thermodynamics it was an aim to introduce a quantitative measure for what in colloquial terms would be called heat. It went without saying that this should be a state variable. At the end of the 18th century Joseph Black introduced such a quantity. From a modern point of view, Black’s heat is best identified with the entropy. However, since the middle of the 19th century, the name heat was redefined as a so-called form of energy, i.e. as a non-state variable. Thereby, Black’s heat disappeared from physics, until it was reintroduced by Clausius with the name entropy. Since Clausius defined the entropy via the non-state variable heat, it appeared worthwhile to emphasize that the entropy is a state variable. Only much later it was recognized that the newly introduced entropy was essentially identical with the heat concept from the time of Black and Carnot [1, 2].

Pressure is often introduced via the force. A force is always exerted by a body on another. Force is clearly a concept from the time when mechanical interactions were interpreted as actions at a distance. As a result, it is natural that the student looks for a body which exerts the pressure, and one on which it is exerted. In order to put him off from this wrong expectation, one stresses that pressure is a state variable. This explanation is only needed because the pressure was introduced inappropriately from the beginning [3].
**Disposal:**

Small solution: One does not say that internal energy and entropy are state variables – that should be clear anyway – but one stresses that work and heat are two unusual constructions, which do not fit in the pattern of the other physical quantities.

Large solution: One does completely without the introduction of separate symbols and names for the expressions which one usually calls work and heat. As a teacher one might at first have the feeling that something important is missing. But one will soon discover that nothing is missing, and that at the same time one gets rid of some conceptual problems.

One can also confidently omit the designation “state variable” in connection with pressure. Instead of introducing the simple quantity pressure via the difficult quantity force, one introduces the pressure as an independent quantity, for instance beginning with a pressure difference: A pressure difference is the cause for a water or air flow. Then it is no longer necessary to mention that pressure is a totally normal quantity – a “state variable”. The suspicion that it would be otherwise does not arise.

[1] Callender, H. L.: The caloric Theory of Heat and Carnot's Principle. – Proc. Phys. Soc. London 23 (1911). – S. 153: “Finally, in 1865 when [the importance of caloric] was more fully recognised, Clausius gave it the name of 'entropy', and defined it as the integral of \(\frac{dQ}{T}\). Such a definition appeals to the mathematician only. In justice to Carnot, it should be called caloric, and defined directly by his equation..., which any schoolboy could understand. Even the mathematician would gain by thinking of a caloric as a fluid, like electricity, capable of being generated by friction or other irreversible processes.”


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