The Concept of Heat from the Accademia del Cimento to Sadi Carnot

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Contents

Part 1

GOALS OF THIS WORKSHOP

It seems that the Experimenters of the Accademia del Cimento are using a basic human conceptualization of processes to explain thermal phenomena. We may learn important things from listening to them.

In particular, we might finally understand Sadi Carnot's title of his famous book *La puissance motrice du feu*…

EVIDENCE FOR THE GESTALT OF PHYSICAL PROCESSES

The concept of heat in the Accademia del Cimento

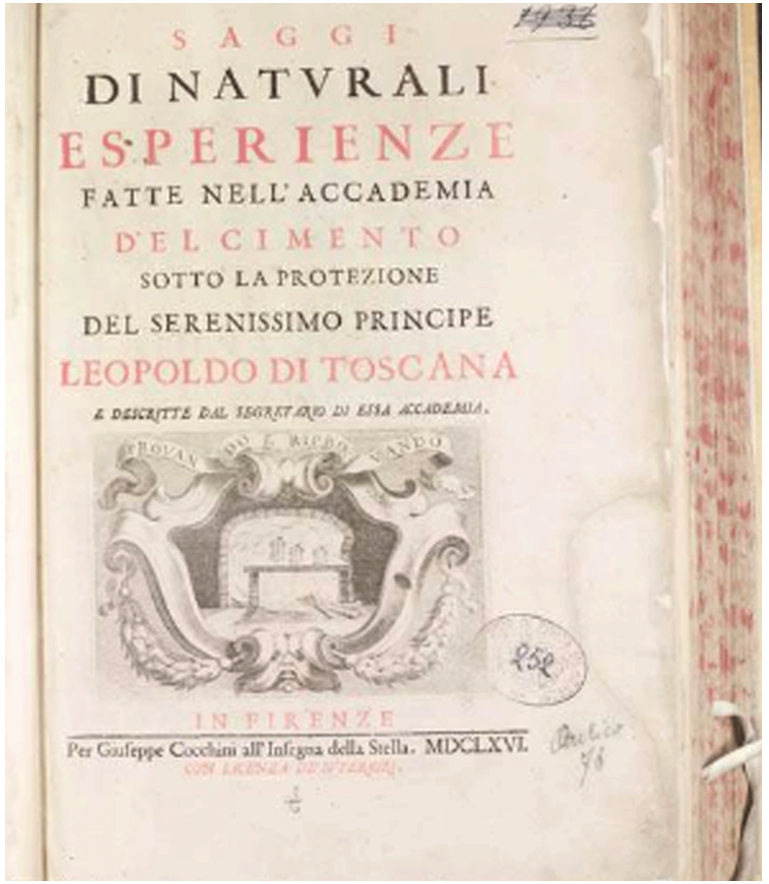
The concept of heat of the members of the Accademia del Cimento: Saggi di naturali esperienze… (1667)

M. Wiser and S. Carey (1983): When Heat and Temperature were one.

"The Experimenters' concept of heat had three aspects: **substance** (particles), **quality** (hotness), and **force**."

A weakly differentiated gestalt

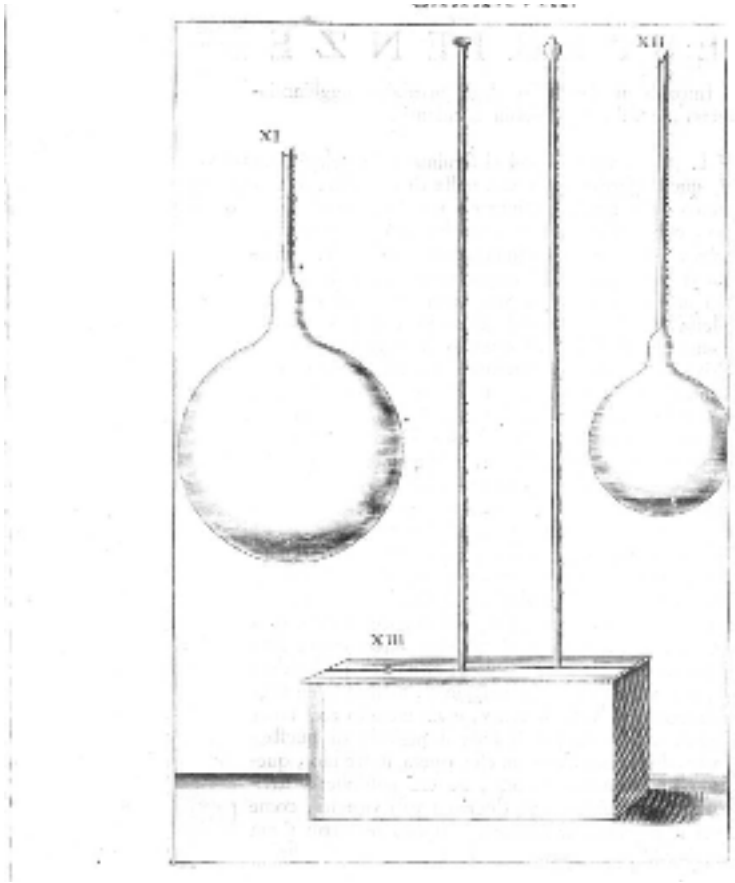
It seems that the Experimenters did not really distinguish between these aspects of the gestalt of heat.


SAGGI
DI NATVRALI
ESPERIENZE
FATTE NELL' ACCADEMIA
DEL CIMENTO
SOTTO LA PROTEZIONE
DEL SERENISSIMO PRINCIPE
LEOPOLDO DI TOSCANA
E DESCRITTE DAL SEGRETARIO DI ESSA ACCADEMIA.
IN FIRENZE
Per Giuseppe Cocchini all' Insegna della Stella. MDCLXVI

The concept of heat of the members of the Accademia del Cimento: Saggi di naturali esperienze… (1667)

The description of thermal phenomena by the Experimenters demonstrates clearly the image corresponding to direct causation: Hot or cold bodies are the sources of heat or cold. Heat or cold are emitted by the sources, and they influence other bodies. The Experimenters were interested in the “force” or “power” of heat (or of cold).

See M. Wiser and S. Carey (1983)



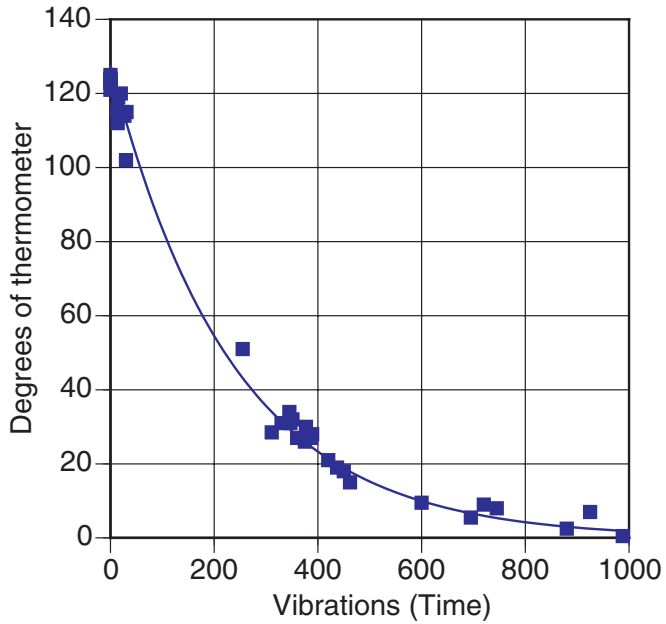
GOALS

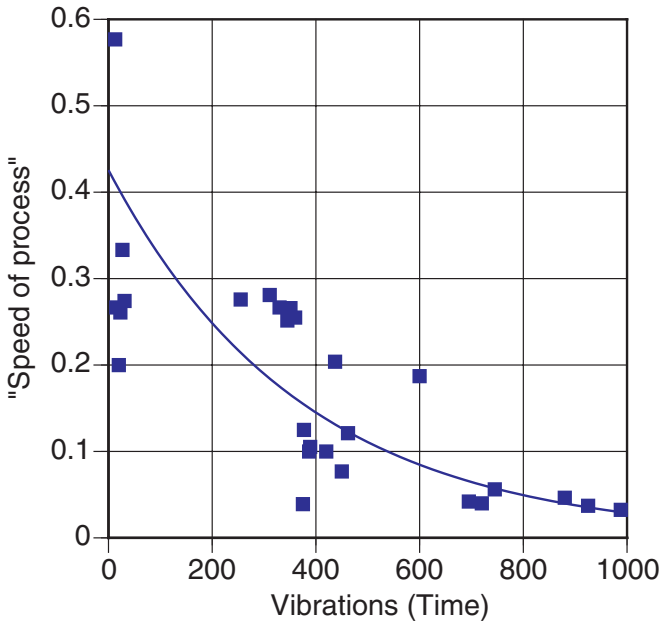
In this short period, we cannot expect to read much of the Saggi di Naturali… Still, we may get a first good feeling for the importance of language and concepts that today seem so strange to us…

- Try to answer the question of why the experimenters used a clock and reported changes of “degrees” of their thermometer and intervals of time in their tables.
- Try to answer the question of why they placed their “thermometer” outside of the bulb containing the water whose cooling and freezing they were interested in.
- Try to see—as much as possible—if the thermal concept of the experimenters included the three aspects of quantity, intensity, and foce (power).
- What might the experimenters have meant by their concept of “force of heat”?
- Did the experimenters have a concept of thermal equilibrium?

SOME POSSIBLE ANSWERS…

Here are diagrams showing the readings of the “thermometer” as a function of time during the freezing experiments, and the “speed of the process” a measure of the “force of heat,” again as a function of time (only the “First Freezings…” were taken; Saggi di Naturali, pp. 156-165).





Part 4

FROM THE SAGGI DI NATURALI TO SADI CARNOT

For the Experimenters of the Accademia del Cimento, the force of heat was most important. Sadi Carnot continued this tradition, but he could base his work on a well structured—and consciously structured—gestalt of thermal processes.

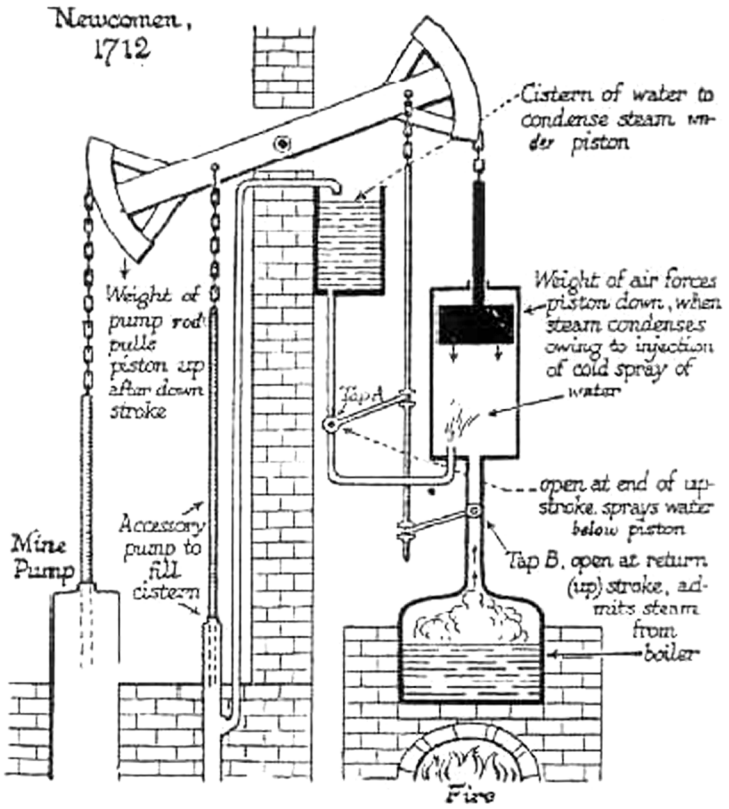
It seems he was the last one who really did this…

SADI CARNOT'S IMAGE OF THE POWER OF HEAT

Sadi Carnot (1796-1832)

Réflexions sur la puissance motrice du feu

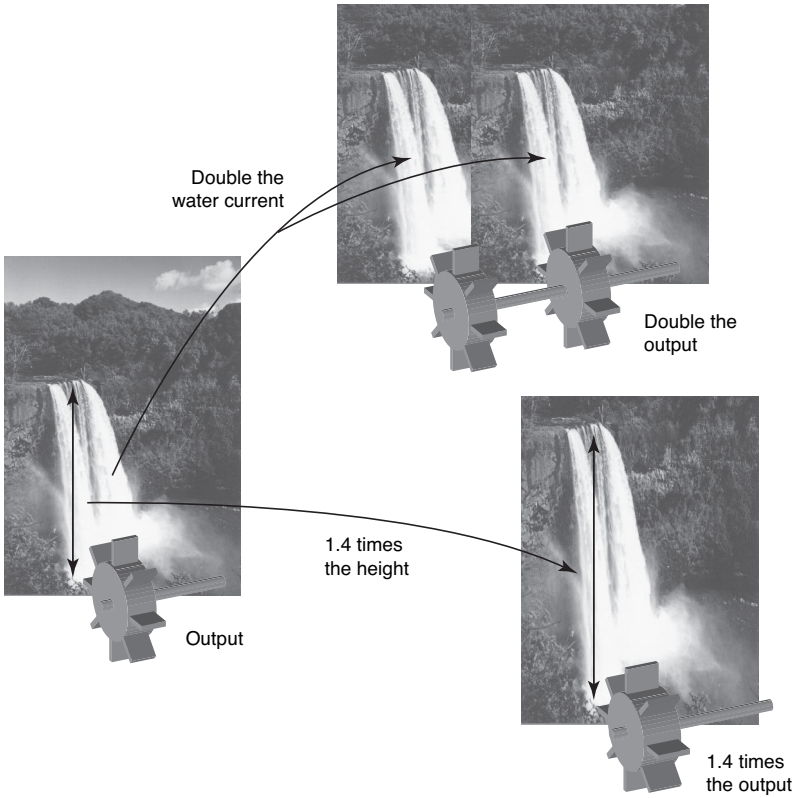
D'après les notions établies jusqu'à présent, on peut comparer avec assez de justesse la *puissance motrice de la chaleur* à celle d'une chute d'eau […]. La puissance motrice d'une chute d'eau dépend de sa hauteur et de la quantité du liquide; la puissance motrice de la chaleur dépend aussi de la quantité de calorique employé, et de ce qu'on pourrait nommer, de ce que nous appellerons en effet *la hauteur de sa chute*, c'est-à-dire de *la différence de température* des corps entre lesquels se fait l'échange du calorique.



DIAGRAMMATIC VIEW OF NEWCOMEN'S ATMOSPHERIC OR FIRE ENGINE (1712)

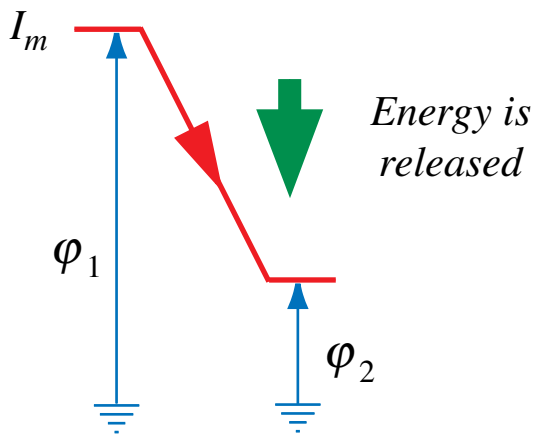
ENTAILMENTS OF THE METAPHORIC STRUCTURE OF PHYSICAL CONCEPTS

An example of entailments that can be brought into quantitative form

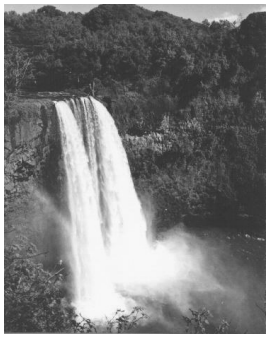


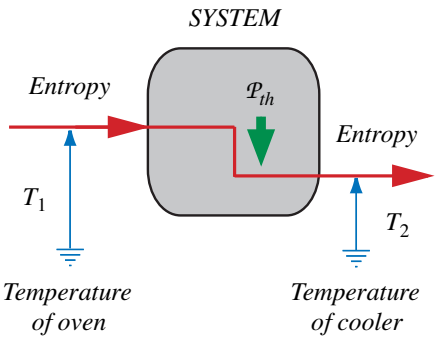
$$Power =$$

$$Level\ difference \cdot Current\ of\ substance$$

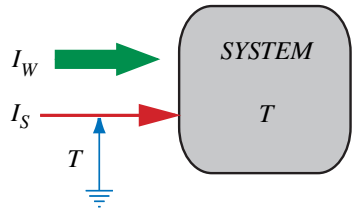


ENERGY IN THERMAL PROCESSES

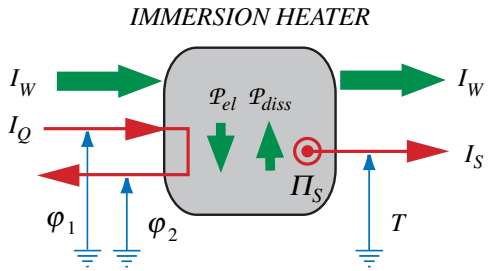




Thermal power= Temperature difference· Entropy current



Energy current in heating and cooling= Temperature · Entropy current



Dissipation rate= Temperature · Entropy production rate

LITERATURE

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