Summary of course C.8-2: Elements of Methodology (1996/1997).

General Overview

This course deals with applied logic: the theory and practice of applying the laws of logical thought to various fields of knowledge in a purposeful and orderly manner.

Through a series of representative examples and selected cases, the course demonstrates how scientific knowledge is constructed. The process begins with mathematical and formalized thinking, in which concepts are precisely delimited by means of axioms, sets and syntactic rules.

Attention then shifts to empirical and causal induction, in which observations lead to regularities through testing and causal analysis (such as the methods developed by Bacon and Mill).

In the human and social sciences, the emphasis is placed on hermeneutics, intentionality and the human being as the giver of meaning to the world around them.

The concluding topics include the philosophy of science, systems thinking in control theory (cybernetics and computer science), and the social relevance of rhetoric and applied reflection.

1: Foundations of Methodology and Mathematical-Formalized Thinking

Whereas pure logic focuses on the formal rules of inference, methodology is the theory of the systematic application of these logical laws to specific fields. Acting methodically means proceeding purposefully and systematically in order to acquire systematic knowledge (science). In methodology, the subjective system (the organized body of knowledge in the mind) and its objective expression in sentences form a close unity.

Mathematical thinking constitutes a primary model of applied logic. Mathematics can be characterized as the science of quantity, number and space, supplemented by a system of symbols that connects these dimensions. In modern abstract mathematics, set theory serves as the central paradigm: all mathematical objects (such as numbers or groups) are reduced to sets and the relationships between them.

A crucial step in methodological development is the transition from numerical arithmetic to literal algebra (the analysis developed by François Viète) and to formalized language. By working with variables (letters used as ‘placeholders’ or lemmas), thought follows strict syntactic rules. This enables

humans to perform complex operations mechanically and without error, even when the direct substantive meaning is not constantly kept in view.

Mathematical objects can be defined in two ways: genetically (by describing the process through which the object comes into being, such as the circle generated by a rotating line) or axiomatically. An axiomatic system (such as Peano's definition of the natural numbers) constitutes a 'collective concept' or system: a set of unproven basic assumptions and fundamental concepts from which all further propositions are consistently derived.

2: The Empirical Cycle, Induction and Causal Investigation

In the empirical sciences, purely deductive inferences from axioms are insufficient; reality itself must be consulted. This process follows the empirical cycle:

- Observation (observing data).
- Hypothesis formation (formulating a provisional assumption or lemma).
- Deduction of testable predictions.
- Testing (carrying out samples or trials, passively or actively/experimentally).
- Evaluation (verifying or falsifying the hypothesis).

Reasoning from specific observations to general rules is called induction. Logic distinguishes between summative induction (merely summarizing cases that have already been tested) and ampliative, or knowledge-expanding, induction (inferring from tested samples to all possible cases, including those not yet tested). Induction can be universal (when a rule applies in 100% of cases) or statistical/ probabilistic (when sample percentages and randomization are used).

When investigating the cause of a phenomenon, methodology employs causal induction. Following in the footsteps of Francis Bacon, John Stuart Mill formulated his classical experimental methods:

- The method of agreement: when a phenomenon repeatedly exhibits one common factor under different circumstances, that factor is considered its cause.
- The method of difference: when a phenomenon occurs in one case but not in another, and the two cases differ in only one circumstance, that circumstance is considered the cause (as in Pasteur's experiments on germ-free air).
- The method of concomitant variation: when a change in the cause produces a proportional change in the effect.

A complete cause requires the combination of all the necessary and sufficient conditions that adequately explain the phenomenon.

3: Human Sciences, Hermeneutics and Subjectivity

When methodology focuses on human beings and society (the humanities and social sciences, or the alpha and gamma sciences), it encounters the fact that human beings are not deterministic physical objects, but free, meaning-giving and acting beings. Research in the human sciences therefore requires a specific approach that differs from that of the exact and natural sciences.

Wilhelm Dilthey introduced hermeneutics, or the interpretative method (*Verstehen*), for this purpose. Since the inner life of the soul (*Erlebnis*) of another person cannot be measured directly, the researcher interprets expressions (*Ausdruck*) - such as language, art, actions and institutions - as signs in order to attain understanding (*Verständnis*). This is related to the dialogical induction of Socrates and Plato, in which conversation and the confrontation of differing viewpoints (perspectives) gradually lead to a more comprehensive understanding of reality.

In the human sciences, the intentionality of the judging subject plays a decisive role. A judgement is never an isolated mechanical fact; it is partly determined by the person expressing it, their values, attitude and pragmatic context. This explains the difference between a healthy and a neurotic mind (whether or not one rigidly clings to frustrating interpretative frameworks) and the influence of ideology. An ideologue adds an 'exclusive axiom' to their framework of thought ("only these factors explain everything"), thereby narrowing their field of vision and refusing to acknowledge facts that fall outside their theory.

4: Philosophy of Science, Cybernetic Thinking and Computer Science Methods

Epistemology (the theory of scientific knowledge) investigates the conditions and scope of scientific knowledge. Whereas Karl Popper emphasized that scientific theories must continually be subjected to falsification, Paul Feyerabend pointed out that, historically, scientific progress often proceeds in a chaotic and non-linear manner. In practice, scientists are guided not only by pure logic, but also by tradition, authority, preference and temporary paradigms.

An important overarching model of thought in modern methodology is control theory, or cybernetics (studied by, among others, Norbert Wiener). This

systems-based approach to control has ancient roots in the concepts of order, deviation and restoration. A dynamic system (biological, technical or social) is characterized by:

- Input of matter, energy or information.
- Internal transformation through self-regulation and homeostasis.
- Output.
- Feedback to correct deviations from the intended goal.

Closely related to this is computational thinking. A computer is an information-processing system in which hardware (equipment) and software (programs) work closely together. The core of programming is the algorithm: a binding, logically correct and finite sequence of instructions (sequential, iterative or selective) that solves a problem step by step. Advanced developments, such as neural networks and chemical retrosynthesis (as exemplified by the LHASA computer system), demonstrate how algorithmic structures can process complex patterns and molecular combinations.

5: Rhetorical Reasoning and Social Practice

In everyday social and communicative life, reasoning rarely follows the strict, irrefutable rules of the academic syllogism. Rhetorical reasoning, or the enthymeme, is an abbreviated argument in which one of the premises or the conclusion is left unstated because it is assumed to be known or self-evident. Whereas scientific argumentation strives for apodictic certainty, rhetoric focuses on persuasion within a context of probability and the formation of human opinions.

Ultimately, methodology is not merely a theoretical activity; its value is demonstrated in practice, entirely in the spirit of Charles Peirce's pragmatic maxim: "You shall know concepts by their fruits." This is reflected in a variety of social applications:

- *Business and consultancy philosophy*: using reflection and conceptual analysis to structure and solve concrete policy, professional or life problems clearly.
- *Philosophy with children*: encouraging an original, questioning and logically grounded attitude from an early age through stories and dialogue, in order to move beyond superficial slogans and dogmatic judgements.

Methodology thus teaches people to move responsibly between abstract conceptual frameworks and concrete, changing reality.