oestros №6 (2012)

The sum of the parts

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Abstract

Reflections on approaches to 'the whole' (όλον [Gk]) and repercussions for procedures.

1 Introduction

Ca. 300 BC, Euclid in his *Elements* states axiomatically that 'the whole is equal to the sum of all its parts' (Casey, 1885). Expressed somewhat more technically, the idea can be formalised as in Figure 1. In its original context of geometry, the axiom refers to entities such as triangles — for instance, 'the sum of the angles of a triangle is equal to 180°'. In the context of an 'exact science', such a certainty is usually quite welcome.

$$\mathrm{W} = \sum_{i=1}^{n} \mathrm{P}_i$$

Figure 1 Euclid's axiom

An earlier [but posteriorly denominated] work of reference on the issue of entities, *Metaphysics* (Aristotle, 350BC), is concerned extensively with the 'essence' or ουσία [Gk] and its 'unity' — that is, the state of forming a complete and harmonious 'whole' or όλον [Gk]. Aristotle holds that for 'things which have several parts and in which the totality is not [...] a mere heap, but the whole is something beside the parts, there is a cause' that accounts for a 'communion', 'connexion', or 'composition' (Aristotle, 350BC, Book VIII, Part 6). In this case, 'the whole' is what we would nowadays call a 'system', and Aristotle's idea could be written as in Figure 2.

$$\mathrm{W} > \sum_{i=1}^{n} \mathrm{P}_i$$

Figure 2 Aristotle's tenet

ISSN: 2182-8113

2 Context

It would be paradoxical if Euclid and Aristotle were both right while making opposite statements, but one should also look at the context in each case. When working with objects such as those of geometry, it is easy to trust (or assume) that all the parts of an entity such as a triangle are exposed, duly marked and, above all, visible. After all, a triangle is a simple static system. So, Euclid was right to establish the equality axiom between a whole and its parts (Figure 1), under these conditions.

On the other hand, most of Aristotle's objects of study had been living organisms in their habitats, including humans in society. It is easy to appreciate that there is hardly any documentation about such objects. Sometimes even visual evidence is hard to obtain, either due to the scale of the objects (extremely large or small for a human observer), or due to the invisibility of the objects, as is the case with 'relations' or 'interactions' that make up a 'whole'. So, Aristotle was right to establish his inequality (Figure 2), recognising that not everything is visible (or perceptible, *sensu lato*), and because of this some 'parts' may be unintentionally ignored.

3 Choices

Over the centuries, Aristotle has had a great influence in the natural sciences and philosophy, while Euclid mostly in the exact sciences and engineering. Both teachers have had their direct and indirect disciples, who may have favoured one of the two ways of thinking depending on their context of study and work, or perhaps depending on the choice made by the school where they studied.

People pressed for 'hard facts' — which is often the case with 'decision makers' — may simplify too much, too early, or too unskilfully, at the cost of appropriate understanding (Perdicoúlis, 2012). That is, they may look for the obvious indications (or parameters) of an entity, and describe it with an apparent Euclidian rigour. A very common approach, even in the scientific domain, is the use of sets of [loose] indicators for the representation of a 'whole' — e.g. a system or a situation (Perdicoúlis and Glasson, 2011).

Taking the Aristotelian approach would require a search for the links or relations between these obvious indications — a pre-cursor of 'systems thinking'. This search often reveals the limitations of existing knowledge and requires (a) new research, which needs significant time and money, or (b) proceeding with assumptions, which are risky and 'un-scientific' if used un-tested or un-proven.

4 Challenges

'Information shortcuts' such as hasty simplifications presented in a formal language so that they appear studied and credible are quite dangerous. It is more honest (and scientifically valid) to acknowledge ignorance or the information that has been excluded — either by choice or unavailability — than to oversimplify and pretend that 'everything is under control'. The domains where we are really in control of information are likely to be very few in the real world, and perhaps their vast majority in virtual or highly abstracted environments such as [Euclidian] geometry.

It is a hard choice when to admit that everything to be known is visible or already known precisely, as in Euclid's equality, or when to admit that we must look for unknowns, as in Aristotle's inequality. Euclid's attitude is tempting and more suitable for decision making, but safe only in simple and well known systems. Aristotle's attitude is more suitable for complex and less well-known systems, and prompts for the art of 'systems modelling'. This implies much more work before decisions can be made — except these are likely to be made with more understanding, hence more wisely.

References

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