Contents

CHAPTER 1 Preliminary Remarks about the Concept of Information

By way of introduction, we shall consider a few systems and repeatedly ask the question: What is the reason that such a system can function?

1. The web of a spider: In Figure 1 we see a section of a web of a spider, a *Cyrtophora* in this case. The mesh size is approximately 0.8 x 1.2 mm. The circle in the upper picture indicates the part which has been highly magnified by an electron microscope to provide the lower picture. The design and structure of this web is brilliant, and the spider uses the available material extremely economically. The required rigidity and strength are obtained with a minimal amount of material. The spiral threads do not merely cross the radial ones, and the two sets are not attached at the points of intersection only. Rather, they run parallel over a small distance, where they are tied or "soldered" together with very fine threads.

Every spider is a versatile genius: It plans its web like an architect, and then carries out this plan like the proficient weaver it is. It is also a chemist who can synthesize silk employing a computer controlled manufacturing process, and then use the silk for spinning. The spider is so proficient that it seems to have completed courses in structural engineering, chemistry, architecture, and information science, but we know that this was not the case. So who instructed it? Where did it obtain the specialized knowledge? Who was its adviser? Most spiders are also active in recycling. They eat their web in the morning, then the material is chemically processed and re-used for a new web.

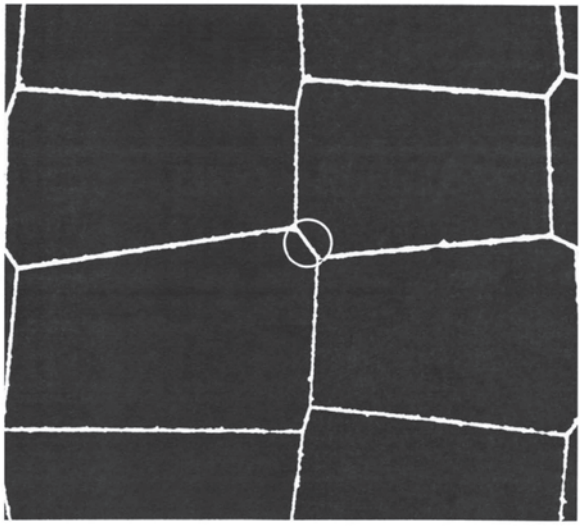
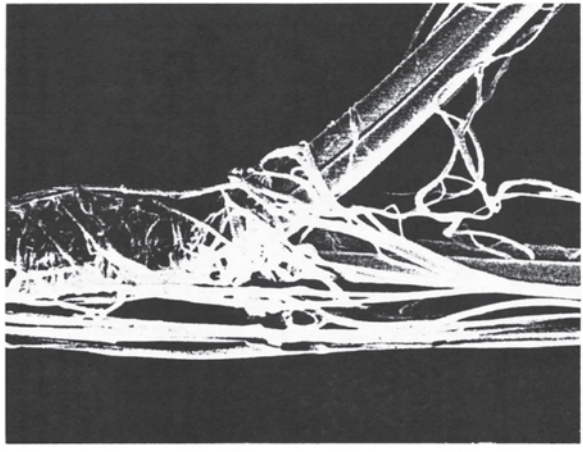


Figure 1:
The web of a *Cyrtophora* spider.



The answer to the question of why everything works in this way is unequivocally that *information* plays an essential role.

2. The spinnerets of *Uroctea*: The spinning nipples of *Uroctea* spiders are shown in Figure 2 under high magnification. The female has 1,500 spinnerets, only a few of which appear in Figure 2, where threads can be seen emerging from two of them. Silk having the required tensile strength is produced in the "factories" located directly below the spinnerets. All these complex processes are computer controlled, and all the required equipment is highly miniaturized. How is it possible that such a complex and minutely detailed manufacturing process can

Figure 2: The spinnerets of *Uroctea*.

be carried out without mishap? Because the system contains a controlling program which has all the required processing information (see chapter 7).

3. The *Morpho rhetenor* butterfly: The South American butterfly, *Morpho rhetenor,* is depicted in Figure 3 under various magnifications so that the detailed structure of its wing scales can be seen (*Scientific American*, vol. 245, Nov. 1981, p. 106). The wings exhibit marvelous colorful patterns; metallic blue above (top left) and brown underneath (top right). The wings were analyzed for pigmentation, but none was found. How can this colorful beauty then be explained?

The detailed structure of the wings becomes apparent in three magnification steps, namely 50 x, 350 x, and 20,000 x. At the lower magnifications, the structure resembles roof tiles, but when the magnification is 20,000, the secret is revealed. The structure is quite extraordinary: a

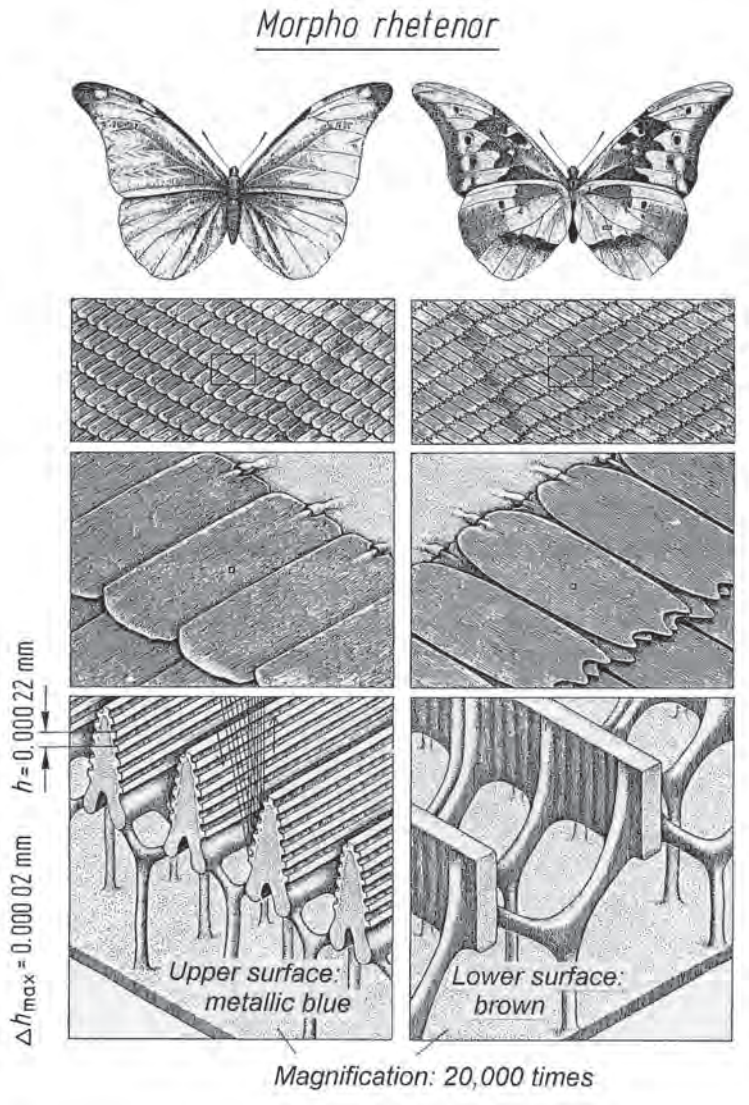


Figure 3: The South American butterfly *Morpho rhetenor* with wing surface sections under different magnifications.