GST 67 – Subsystems

Formal Description

A subsystem is a component of a larger system that is itself a system. It possesses its own causal organisation and exhibits emergent properties, behaviours or outputs that arise from the organisation of its own components, while simultaneously contributing to the emergent properties, behaviours or outputs of the larger system.

Plain English Explanation

Many systems are composed of smaller systems. These smaller systems are called subsystems.

A subsystem differs from an ordinary component because it is itself a functioning system. Like every system, it possesses its own organised causal interactions and exhibits emergent properties, behaviours or outputs that arise from the way its own components are organised.

An ordinary component need not possess these characteristics. It may be an assembly or a pre-systemic assembly whose internal organisation has not yet generated emergent capabilities of its own. Although such components contribute to the operation of the larger system, they are not themselves subsystems.

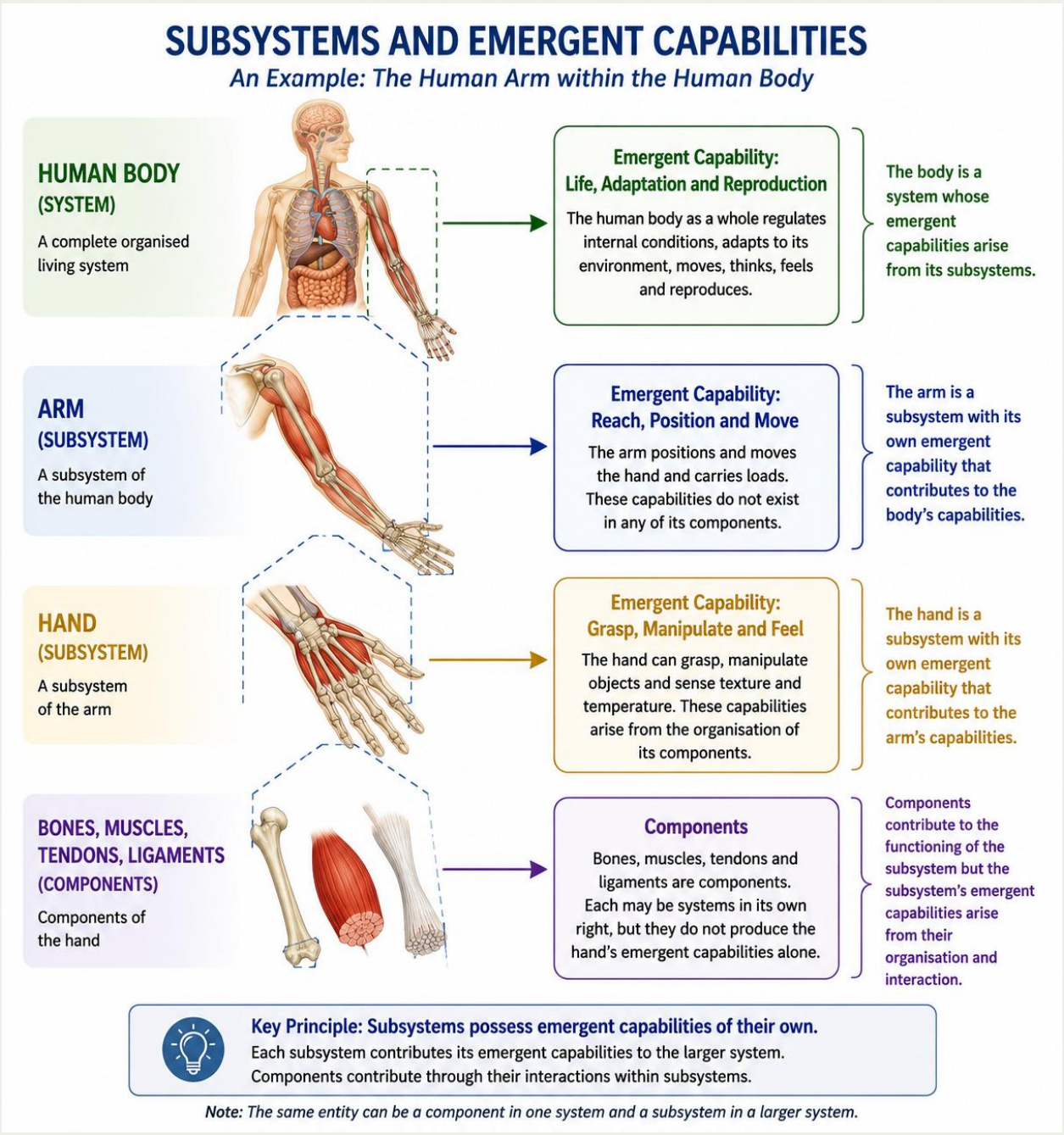
Consider a motor car. The engine is a subsystem because it is itself a complex system. Its pistons, valves, crankshaft and other components interact to generate emergent capabilities such as converting fuel into controlled mechanical power. The engine then contributes these capabilities to the operation of the vehicle as a whole.

The same principle applies throughout nature and society. A human heart is a subsystem of the circulatory system. It possesses its own organised structure and emergent capability to pump blood, while contributing to the functioning of the organism. Similarly, a university department may be regarded as a subsystem of the university because it has its own organisation, staff, procedures and outputs, while also contributing to the operation of the university as a whole.

Subsystems illustrate one of the fundamental characteristics of complex systems: recursive organisation. Systems are frequently composed of smaller systems, each contributing its own emergent capabilities to the larger system while simultaneously possessing emergent capabilities of its own.

Recognising subsystems helps us investigate complex systems efficiently. Rather than analysing every individual entity simultaneously, we can study the behaviour of subsystems and the causal interactions between them. This allows us to understand complex systems at an appropriate level of detail while preserving the essential patterns of causal organisation.

In the following modules we shall examine how subsystems are organised into hierarchies, bounded systems and wider environments.



Investigative Context:

In this example, bones, muscles, tendons and ligaments are represented as components because the investigation concerns the emergent capability of grasping. In reality, each of these entities performs multiple biological roles and may itself be regarded as a complete system in other investigations. For example, bones continually remodel themselves, store minerals and produce blood cells. In a different investigation, any of these entities could be represented as the system of interest and studied as a system in its own right. The underlying reality remains unchanged; only the representation changes.

Examples

The digestive system is a subsystem of the human body. Its organs interact to digest food and absorb nutrients, giving rise to capabilities that no individual organ possesses independently. These emergent capabilities contribute to the functioning of the organism as a whole.

A computer processor is a subsystem of a computer. It contains billions of interacting electronic components whose organised causal interactions generate the capability to execute instructions. Groups of transistors contribute to this behaviour but are not themselves subsystems.

Provenance and Links

The recursive organisation of systems has long been recognised within General Systems Theory and related disciplines. Many systems theorists have observed that complex systems are composed of smaller interacting systems which themselves form components of larger systems. Within General Systems Theory, a subsystem is distinguished from an ordinary component by possessing its own organised causal organisation and emergent properties, behaviours or outputs. This recursive emergence enables complex systems to be understood at multiple levels of organisation.

Practical Exercise

Choose a familiar complex system such as a motor car, a hospital, a computer or a biological organism.

Identify three components of the system.

For each component, decide whether it should be regarded as:

- an assembly,
- a pre-systemic assembly,
- or a subsystem.

For every subsystem identified, describe the emergent property, behaviour or output that makes it a system in its own right.

Finally, explain how each subsystem contributes its own emergent capabilities to the functioning of the larger system.