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Systems, Messes and Interactive Planning[1]

The Machine Age

Machine Age thinking was *analytical* and based on the doctrines of *reductionism and mechanism.*

Reductionism is a doctrine that maintains that all objects and events, their properties and our experience and knowledge of them, are made up of ultimate elements, indivisible parts. For example, the physical sciences, which ruled the scientific roost during the Machine Age, maintained that everything was ultimately made up of indivisible particles of matter called *atoms*. Although the concept of the atom is generally believed to have been first suggested by the ancient Greek philosopher Democritus in about 420 B.C., it languished for almost two thousand years. It was revived in the Renaissance by such important thinkers as Giordano Bruno, Francis Bacon, René Descartes and Isaac Newton; but as a philosophical rather than a scientific idea. It did not emerge as an important scientific concept until the latter part of the eighteenth century. Since then, the concept of the atom, which no one has ever observed directly, has undergone progressive development; for example, it was later taken to be made up of particles of energy. But it remained the ultimate particle of matter. Today some believe the atom itself has parts called "quarks" or "partons," but they do not deny the existence of some kind of ultimate particle of matter.

Atoms were taken to possess energy and energy was conceived as the power of doing work. Work, in turn, was defined as the production of an effect on matter; for example, moving or transforming it.

Chemists reduced the different kinds of matter to different kinds of elementary substances. Biologists accepted the cell as the ultimate element of life. Gottfried Wilhelm von Leibniz (1646–1716), a major German philosopher and mathematician, postulated the existence of psychic elements—*monads*. John Locke (1632–1704), an equally distinguished British philosopher and prepsychologist, argued for the existence of ultimately simple elements of experience and knowledge—"simple ideas." Much later Sigmund Freud, the founder of psychoanalysis, reduced personality to the interaction between three ultimate elements: the *id, ego* and *superego*. In addition, he and most psychol-

[1] Portions of Chapters 1 and 2 of *Redesigning the Future*. New York/London: Wiley, 1974.

ogists postulated the existence of such indivisible elements of psychic energy as instincts, drives, motives and needs.

Every science sought ultimate elements. But these elements were ranked in order of complexity. Because it was believed that what we experience directly are physical things and their properties, ultimate reality was taken to be physical. Therefore, physics was considered to be the basic experiential science. Even the basic concepts used in other sciences were taken to be derivable from those used in physics. Chemistry was taken to be based on physics, biology on chemistry, psychology on biology and the social sciences on psychology. These dependencies were believed to be one-directional. Nature was believed to be organized hierarchically, as science was.

Analytical thinking is a natural complement to the doctrine of reductionism. It is the mental process by which anything to be explained, hence understood, is broken down into its parts. Explanations of the behavior and properties of wholes were extracted from explanations of the behavior and properties of their parts. The temperature of a body, for example, was explained as a function of the velocity of the particles of matter of which it was composed. An automobile's behavior was explained by identifying its parts and explaining the behavior of each and the relationship between them.

Analysis was also central to problem solving. Problems to be solved were first cut down to size; that is, reduced by analysis to a set of simpler problems. The simpler problems were then solved and their solutions were assembled into a solution of the whole. If the problem to be solved could be reduced to a set of independent subproblems, then the solution to the whole was nothing more than the sum of the solutions to its parts. For example, the problem of running a city was broken down into running transportation, housing, health, education, police and so on. It was believed that if each of these functions was managed properly, even if independently of one another, then the city as a whole could be run properly.

When the whole to be explained could not be disassembled into independent parts, the relationship between them had to be understood in order to understand the whole. Consistent with reductionism, it was believed that all interactions between objects, events and their properties could be reduced by analysis to one fundamental relationship—*cause-effect*. One thing was said to be the cause of another—its effect—if the first was both *necessary* and *sufficient* for the other. An effect could not have occurred unless its cause had, and it had to occur if its cause had. For example, if striking a bell is considered necessary and sufficient for it to make a sound, then the strike is taken to be the cause and the sound to be its effect.

Because a cause was taken to be sufficient for its effect, nothing was required to explain the effect other than the cause. Consequently, the quest for causes was *environment-free*. It employed what is now called closed-system

thinking. Laws—like that of *freely* falling bodies—were formulated so as to exclude environmental effects. (The vacuum in which free falling can occur is a *nonenvironment.*) Specifically designed nonenvironments—*laboratories*—were used to exclude environmental effects on phenomena under study.

Environment-free causal laws permit no exceptions. Effects are completely determined by causes. Hence the prevailing view of the world was *deterministic*: everything that occurred in it was believed to be completely determined by something that preceded it. And since it was believed that everything and every event could be reduced to particles of matter and their motion, every phenomenon was believed to be explainable in principle by the laws that governed matter and motion. This belief applied to animate things as well as inanimate. Animate bodies were thus viewed as machines differing in no essential way from inanimate bodies. Hence the physical sciences were believed to be all that is required to explain life. Such as view was called *mechanism.*

Those who held the mechanistic view found no need for teleological concepts—functions, goals, purposes, choice and free will—in explaining natural phenomena. Such concepts were considered to be either meaningless, illusory or unnecessary in science. Philosophers were left to deal with the dilemmas their exclusion produced.

Carried to its limit, reductionistic causal thinking yielded a conception of the *universe as a machine.* It was believed to be like a hermetically sealed clock, an environment-free self-contained mechanism whose behavior was completely determined by its own structure and the causal laws that applied to it. The major question raised by this conception was: Is the universe a self-winding clock or does it require a winder—God? The prevailing belief was that God was required. The world was thus conceived as a machine created by God to serve His purposes, a machine for doing His work. Additionally, man was believed to have been created in the image of God. Hence it was quite natural for men to attempt to develop machines that would serve their purposes, that would do their work.

The Industrial Revolution

Machines, not surprisingly, were thought to be reducible to three basic mechanical elements: the wheel and axle, the lever and the inclined plane. Work was similarly analyzed and reduced to ultimately simple work elements. The process of doing so came to be known as "work study." Machines were developed to perform as many of these basic tasks as was technologically feasible. Men performed those that could not be mechanized. Men and machines were organized into processing networks the apotheosis of which is mass production and the assembly line.