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A General Model of Simple and Complex Systems

By David Alderoty © 2015

Chapter 4) Cycles, Rates, and Cause-and-Effect Sequences of Dynamic Systems

Over 1,900 words

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If you want to go to the table of contents of this chapter left click on these words

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THE FOCUS AND PURPOSE OF THE SYSTEM PERSPECTIVE PRESENTED IN THIS E-BOOK

To prevent confusion, I am placing the following statement at the beginning of each chapter in this e-book. Keep the ideas presented in the following three paragraphs, in mind as you read this e-book.

The main utility of a systems theory, especially the **General Model of Simple and Complex Systems,** is to assist in the study of systems, especially in terms of problem solving, goal attainment, and observational and experimental research. From a system perspective, all the relevant factors of a system are considered to obtain an objective. This can include the behavior and overall functionality of the system, its environment, its components, its structure, and related dynamics, cause-and-effect sequences, inputs, outputs, forces, energy, rates, time, and expenditures.

Examples of a system are atoms, molecules, chemicals, machines, electronic circuits, computers, planets, stars, galaxies, bridges, tunnels, skyscrapers, forests, rivers, streams, oceans, tornadoes, hurricanes, microorganisms, plants, animals, human beings, social groups, small businesses, organizations, political parties, cultures, and the human mind of an individual, including related behaviors and personality traits.

A systems perspective is also useful for writing projects. This involves writing about all the relevant factors of a system, in terms of a thesis, or topic.

The purpose of this e-book is to discuss and explain the many details associated with the systems perspective described above. This required twelve chapters, which are relatively short.

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Cycles & Rates of the Cause-and-Effect Sequences of Dynamic Systems

Definition of a Cycle of a Cause-and-Effect Sequence,

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Based on the way I am using the terminology, one cause-and-effect sequence, is **one cycle**. **If the same cause-and-effect sequence is repeated N times, there are N cycles.** Cause-and-effect sequences are commonly repeated in engines, timing devices, and on assembly lines in factories.

The number of cycles, per unit of time, of a cause-and-effect sequence is the rate. (The rate should be represented in cycles per unit of time.) The following three examples will clarify the ideas presented above:

- If a sequence repeats 10 times a second, its rate is 10 cycles per second.

- If a steam engine requires 1/2 of a second to complete one cycle then the rate is 2 cycles per second.

- If the earth orbits the sun in one year, what is its rate in cycles per century? Answer: The rate is 100 cycles per century

The rate of a cause-and-effect sequence can be important for problem solving, and scientific studies. When the rate is relevant, it should be documented, along with the set of sequential actions that comprise the cause-and-effect sequence.

Note on Cycles Per Unit of Time, and Frequency

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The cycles per unit of time of a cause-and-effect sequence, fits the definition of frequency. Frequency is usually measured in hertz (Hz), kilohertz (kHz), and megahertz (MHz). A hertz is one cycle per second, kilohertz, is one thousand cycles per second, and megahertz, is one million cycles per second. For example, if a cause-and-effect sequence is repeated a hundred times a second, (or 100 cycles per second,) then its frequency is 100 hertz.

Hertz, kilohertz, and megahertz have limited utility, for cause-and-effect sequences, because these units are based on a second. Some sequences involve much longer time intervals, such as 60 cycles per hour, or 100 cycles per century. However, these units are useful for some fast sequences, such as the waves discussed under the following subheading.

Waves, and Cause-and-Effect Sequences

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Waves can be conceptualized as cause-and-effect sequences. One wavelength would represent one cause-and-effect sequence, or one cycle. Waves usually repeat many times a second, which is its frequency. For example, if a sound wave vibrates at 1000 times a second, its frequency is 1000 hertz, which is the same as saying its frequency is 1000 cycles per second. Light waves have very high frequencies, which can be measured in terahertz (THz). One terahertz is one trillion cycles per second. The frequency of visible light ranges from approximately 430 THz, which is red light, to 790 THz, which is violet light.

The Rate of a Cause-and-Effect Sequence, In Relation to the Mass of its Components

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One cycle of a Cause-and-effect sequence can take place, in time intervals ranging from less than a trillionth of a second to over 10 billion years. The important concept here is the mass of the components comprising a cause-and-effect sequence **tends to influence its rate, in terms of cycles per unit of time**. Sequences that have components with lower masses **tend to complete** a cycle in less time than sequences that have components of greater mass. The above is a tendency, and it certainly is **not** always true, which will be explained below.

Thus, a sequence with relatively massive components might have a higher rate, than a sequence with lighter components, in some cases. This tends to happen when the cause-and-effect sequence with heavier components has **significantly more energy** than a similar sequence with **less massive components**. For example, a large steam engine, with massive components, and a **GREAT DEAL OF ENERGY**, might complete more cycles per unit of time, then a steam engine with less massive components, and less energy. This can happen, when the energy involved with the massive steam engine is high enough to compensate for the greater mass of its components. See the examples in the following subsection.

A Comparison of Six Systems, in Terms of Mass, & Rate of Cycles Per Unit Of Time

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Listed below there are six examples of systems, with different masses. **Each of these systems has a cause-and-effect sequence, which takes place at different rates, in terms of cycles per unit of time.** This list starts with the less massive systems, with faster sequences, and progressively leads into the more massive systems, with slower sequences.

Example 1, Light Waves) The frequency of visible light ranges from 430 THz to 790 THz. One THz is equal to one trillion cycles per second. Thus, light can have rates ranging from 430 trillion to 790 trillion cycles per second. The components of light are **photons**, and a mass has been conceptualized (or defined) by Albert Einstein as **zero**. However, website-1 listed below, indicated that a photon has a mass of 5.81×10^{-69} Kg, based on recent experimental evidence. Website-2, provided a calculated mass equivalent for a photon of blue light, which is 5.525×10^{-36} kg. Both of these numbers are extremely tiny, and if they are rounded down to 30 decimal places, the result is zero. Thus, for all practical purposes a photon has zero mass.

Website-1) Theoretical Development For The Photon Mass and The Quantization of The Gravitational Field, First published in Journal of Theoretics, Vol. 5-6, **Website-2)** Thread: Weight of a photon

Example 2, Electrons, and Computer Cycles) Typical computers run at about 3 GHz, which is **3 billion cycles per second**. The cycles are comprised of moving **electrons, which have a mass of 9.109382×10^{-31}kg** according to website-3, and website-4, listed below. This is a very tiny mass, but it is much greater than the mass of a photon.

Website-3) What are the exact relative masses of protons, neutrons and electrons?, **Website-4)** Electron Mass by JEAN TATE on NOVEMBER 15, 2009

Example 3, Sound Waves, Traveling Through Air)

Sound waves traveling through air are comprise of cause-and-effect sequences, consisting of vibrating masses of air. The frequencies that humans can hear are approximately from 30 Hz to 20,000 Hz. However, bats produce ultrahigh frequency sound waves that are over 100,000 Hz, for **echolocation**, which is based on the websites below. Thus, sound waves at a frequency of 100,000 Hz can travel through air. One cubic meter of air is 1.29 kg. With this example, the mass is much greater than the previous examples, and the rate in cycles per second is much lower.

Website-5) Sound Notes, **Website-6)** Frequency of Bat Sonar, **Website-7)** Is there an upper frequency limit to ultrasound?

Example 4, Cycles Based on the Mechanical Rotations of Engines and Motors) The cause-and-effect sequences of mechanical devices are usually much slower than the previous examples. This is because most of these devices encounter significant levels of friction and air resistance, and they **have relatively massive components**, compared to the **previous examples.** Based on my search of the web, I found one practical motor, with a rate of 104,000 revolutions per minute. I came across a couple of homemade devices, on YouTube, which **supposedly** had rates of one half-million to one-million revolutions per minute. Even if we assume that the above claim was accurate, the rate is only 16,667 cycles per second, which is far less than the previous examples.

Website-8) Dyson unveils 'world's fastest motor, At 104,000 revolutions per minute, **Website-9)** 1,000,000 RPM !!! TourneBille Ultra High-Speed (18000 tours par second), **Website-10)** PMBO 2013 ~Russ's Final Entry Video... OVER 1/2 Million RPM NEO Sphere Air Bearing With ABHA Coil, **Website-11)** Very small and extremely fast electric motor - 90,000 rpm

Example 5, Cycles of Planetary Movements) Planets move very fast, but the movements associated with their orbits in terms of cycles is relatively slow. For example, the earth rotates once in 24 hours, and it completes one orbit of the sun every year. This is one cycle per day, for the rotation, and one cycle per year for the orbit around the sun.

The outer planets have much slower orbital cycles than Earth. For example, Saturn requires almost 30 years, to complete one revolution of the sun, and Jupiter requires almost 12 years. Planets closer to the sun have shorter distances associated with orbits, which results in less time to complete one cycle. For example, Venous orbits the sun in approximately 225 days, and Mercury, orbits the sun in 88 days.

Example 6, Stars and Thier Cycles) Cause-and-effect sequences that involve stars range from millions to billions of years. For example, the sun takes approximately 225 to 250 million years to complete one orbit around the center of the galaxy (the Milky Way), based on websites-12, which is listed below: **Website-12)** How long does it take our sun to orbit the Milky Way's center?,

The cause-and-effect sequence associated with the lifetime of a star can range from 3 million to **over** 10 billion years. Large stars have shorter lifetimes than small stars, because they **consume energy at a much faster rate**. Very small stars, (red dwarf star), may last trillions of years, because they consume much less energy. (The ideas in this paragraph are based on website-13, and similar material is presented in websites-14 and 15)

Website-13) How Long Do Stars Last? By FRASER CAIN, **Website-14)** Life Cycle of a Star, **Website-15)** ~ The Life and Death of Stars ~

A Note on the Mass of Waves

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Waves are a form of energy, which are transmitted through a field comprised of particles. Waves generally involve **vibrating particles**, or **vibrating masses** that are **comprised of particles**. *For example, when sound travels through air, it involves vibrating masses of air, which are comprised of molecules. Another example is water waves, consisting of slowly vibrating masses of water.* With the above examples, it should be obvious that the waves have no mass, but the air and water that the waves are traveling through does have mass.

(Even if we consider relativity ($E = mc^2$) with the above examples, the waves still **do not** have any mass. Theoretically, energy from the wave will increase the mass of the field of vibrating particles that the wave travels through, by an extremely tiny quantity. However, the wave itself still does **not** have any mass. With the above example of sound waves, the field of vibrating particles is the air. With the second example, the field is water.)

The concept presented in the first paragraph, with sound waves and water waves as an example, might also apply to light waves. **Specifically**, when light travels through a vacuum, it might be traveling through a field comprised of particles that we have **not** been able to detect, because of limitations in current technology. However, current theories are based on the assumption that light can travel through space **without** a field of particles. This assumption is based on the idea that light waves have the properties of both particles and waves. However, **all** waves involve particles. For example, when sound travels through the air, masses of the air vibrate, which are primarily comprised of molecules of nitrogen and oxygen. Similarly, water waves are comprised of vibrating masses of water, which are ultimately comprised of water molecules.

To go to the first page of this

chapter left click on these words.

HYPERLINK TABLE OF CONTENTS

Below is the hyperlink table of contents of this chapter. If you left click on a section, or subsection, it will appear on your computer screen. Note the chapter heading, the yellow highlighted sections, and the blue subheadings are **all active links.**

To go to the first page of this chapter left click on these words

If you want to go to the next chapter left click on the link below

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