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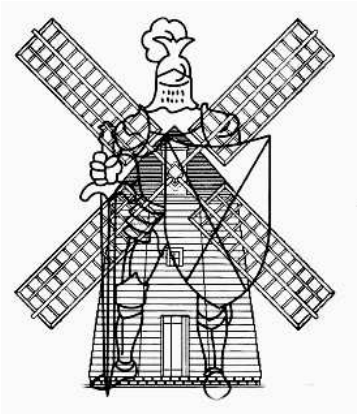
IDEOGRAM : A SIMPLETON IN A COMPLEX FAMILY

2006



"What giants?" said Sancho Panza.

"Those thou seest there," answered his master, "with the long arms, and some have them nearly two leagues long."

"Look, your worship," said Sancho; "what we see there are not giants but windmills, and what seem to be their arms are the sails that turned by the wind make the millstone go."

"It is easy to see," replied Don Quixote, "that thou art not used to this business of adventures; those are giants; and if thou art afraid, away with thee out of this and betake thyself to prayer while I engage them in fierce and unequal combat."

Cervantes, *Don Quixote*. (1605)

In modern times the importance of the atomic theory is even more evident in political than in physical science.

Hegel, *Encyclopedia* , §98 (1817)

PART 1 : GIANTS AND WINDMILLS

My investigation at complexity and simplicity is gradually taking shape and purpose in my own eyes. This e-paper is an opportunity to share the still fuzzy vision.

I am interested in **evolving complex systems**: life, mind, society, language, economy, science, technology, politics, culture, ideology, art, literature, and everything that human history comprises. In particular, I am interested in the limits of our knowledge about such systems. I am not interested in a theory. I am looking for understanding.

I distinguish between knowledge and understanding. Knowledge can be generated, acquired, tested, communicated, modified, falsified, and confirmed independently by different explorers who usually come to the same or close conclusions at the same circumstances. Scientific knowledge stored in natural (physical) sciences is reproducible and lasting. We know how nature behaves and we are expanding our knowledge.

When we deal with very large physical systems, our knowledge can be incomplete and approximate, which is not such a big problem if we know the margins of incompleteness and approximation. In humanities and social sciences consensus is an exception rather than the rule. The inherent fallibility of social sciences is the main tenet of George Soros' view of the world, shaped in long, hard, and truly experimental body of work. His book *The Age of Fallibility: The Consequences of the War on Terror*, Public Affairs, NY, 2006, contains illustrations valuable regardless of his personal position.

Science itself evolves. It is a large evolving complex system. When we deal with **large evolving complex** systems (**ECS- or X-systems**), our knowledge of their behavior is incomplete because of their **size** and **complexity**. This is not a problem in itself because we usually ask questions on a limited and practical scale, unless in philosophy,

where truth matter as much or as little as in art. The main difference of X-systems, as compared to physical systems, comes from the factor of **evolution**: the phenomenon of **novelty** is something physical sciences do not observe in their objects. Novelty, however, matter a lot for a historian of science.

Our knowledge of X-systems is most complete when it is least useful, i.e., when it is about the past and, to a lesser extent, present. We even may know what is going to happen in the future, but almost never know when.

The science of complexity, as the subject of X-systems is usually denoted, was initiated and advanced either by physicists and physical chemists, or by biologists and sociologists who were applying the apparatus of physical sciences to life, society, mind, and even history and culture. Probably, the most significant result of the over half century of science of complexity is the wealth of work in the absence of consensus. I would draw an analogy with *perpetuum mobile*.

The physical sciences do not give us any exact **knowledge** of X-systems, except for about a page of general principles of thermodynamics. This small package, however, contains a true gem of knowledge: the so-called dissipative systems, some very simple and some as complex as X-systems, need a stable source of energy to sustain their size, complexity, and evolution. This energy (**free energy**, to be exact) is irreversibly dissipated into heat, with the difference retained as order.

While most living species use the sun as the ultimate source of energy, modern human civilization, in addition to the sun, relies on limited or hard to get sources of mineral fuel. Their exhaustion will unavoidably bring big changes, but when and of what kind? This question remained purely academic until recently.

A **B** **C** **D** **E** **F**

Figure 1. Evolution of waterwheel (A-C) and windmill (D-F)

A miller's windmill (**Figure 1 D-E**) is an example of a device transforming the energy of the sun—through the intermediate energy of the wind—into mechanical energy for processing grain, another form of stored solar energy needed to sustain human existence. Today this antique contraption is being resurrected and reengineered for generating electricity needed to sustain the civilization of things.

The watermill (**Figure 1 A-C**) was historically a much earlier device, but wind is capricious and omnipresent, while a creek is reliable but of a limited availability. Ultimately it, too, is driven by the sun creating the turnover of water.

I use the remarkable story of the recent windmill awakening as a pretext to pose the following question: could antique forms of social organization, for example, feudal system and monarchy, or even the tribalism, still not quite extinct in the world, be resurrected and redesigned if mineral fuel was exhausted, or for some other reason?

I ask that question—quite topical, in my opinion—to illustrate **thinking in terms of patterns**, which are much more resistant to erosion by time than particular social configurations. No wonder they are hard to kill: they are abstractions and nothing physical can touch them.

I can add another question.

The so-called war on terrorism is a war between two systems, one tribal terrorism and the other the powerful American Republic. Theoretically, the most powerful one should win.

But why is it on defense—if only temporarily—rather than in a victorious sweep it has proved to be capable of? Thinking in such terms, just from the considerations of symmetry, one may conclude that there are some very ancient and weak components in the American social system or its subsystems. Conversely, there are strong sides of tribal society capable of launching suicidal bombing on unprecedented scale.

Taking another angle, politics is always tribal and sometimes even suicidal, to which *One Party Country* by Tom Hamburger and Peter Wallsten (2006) and the midterm elections of 2006 provide scores of illustrations.

The years of the Republican Revolution remind me descriptions of carefully calculated multi-step chemical syntheses. The Republican chemists who saw the inherited (initial) and the desired (final) situation designed the step-by-step process like chemists from Pfizer or Merck, drawing a chain of small transitions from the starting reagents to the final profitable product seen in imagination.

Furthermore, modern democratic political and social institutions, such as governments of big nations, are large evolving complex systems, too, with a lot of order maintained against a lot of chaos, and they need a constant supply of energy in the form of tax revenue and donations.

In **Figure 2** I equipped the two seats of power, US Capitol and Russian Kremlin, with devices for extracting the necessary energy from wind, the inexhaustible (at least in thousand years) source of energy. The Eiffel Tower needs just a touch to become a windmill, but it is not a seat of power.

An interesting although less timely question is how much the political system could change on the supply of energy independent of geopolitical factors. This question itself leads to the next: is it possible to have some understanding of whether we can look for scientific (i.e., based on approximate consensus) answers to such questions.

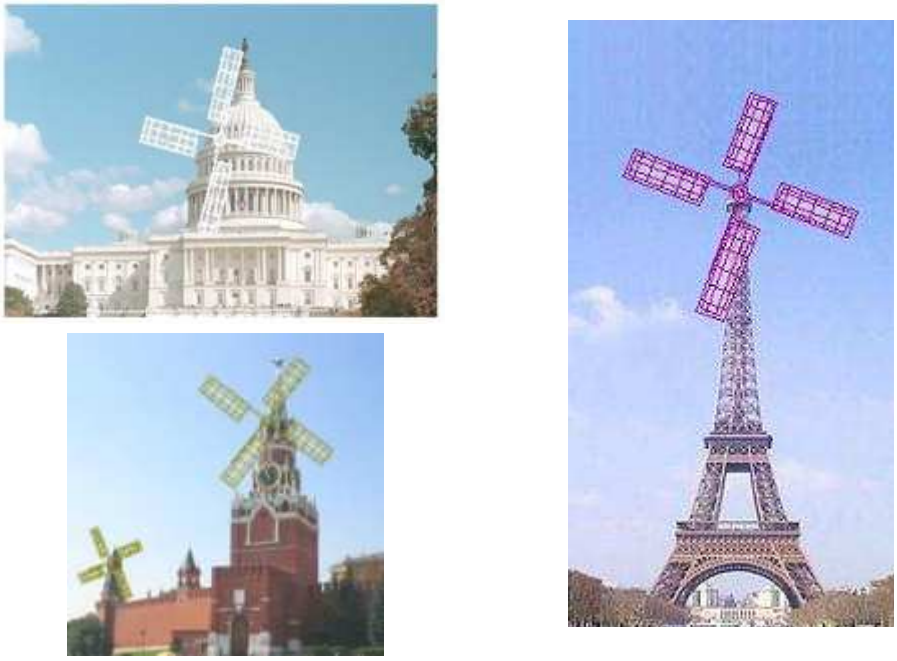


Figure 2. A vision of tax-free governments

I choose "windmill" to be an **ideogram**, i.e., in this case a label for a pattern of a device for extracting energy from long lasting source. I prefer it for its simplicity, but it can serve as a label, a **brand trademark** for the main condition of any X-system: they feed on energy convertible into work (free energy), and they need a lot of it.

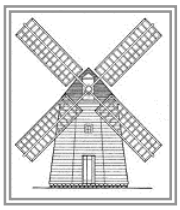
The reason why I do not use the term **pattern** is because it is already used in Pattern Theory (Ulf Grenander) in an exactly defined meaning, while I avoid exact definitions and statements. Counting on understanding rather than knowledge, I tend to recur to the subtle and indirect tools by which art commonly conveys its message to little prepared public. Thus, I believe that the series of photos in **Figure 1** do not even need any caption to convey the message. They speak for themselves.

> **In the language of Pattern Theory ideogram is a simple configuration chosen as a template of a pattern.**

I see ideograms as symbols for universal patterns of building blocks, stratagems, and tactical tricks by which X-systems keep evolving in size and complexity.

Very approximately—to turn to original work of Ulf Grenander would be the best—the potato shape is a pattern, while individual shapes are configurations. To describe the potato shape pattern, we choose a typical potato contour as a template and define the pattern as the template and all its deformations that preserve the potato shape. In case of potato and many other visual images the deformations can be expressed mathematically in terms of group theory. In the case of ideogram we have to drag it through various X-systems, which I doubt can—or should—be expressed through equations. At the level of understanding, however, we can probably do well enough without rigor.

Back to "windmill." In a sense, all life, and the kingdom pf plants in particular, is a system that extracts energy from the inexhaustible source of solar radiation. Plants are all "windmills" in the above sense. In **Figure 1F** we can even see how the wind turbine borrows the architecture from a tree. But there is a radical difference between the windmill and life: the windmill is a thing and life is a system. Energy and materials must be spent on making a windmill, but after that only minor maintenance is needed. The windmill is a **solid thing** with some degrees of freedom. Life is a **steady state** of flux: it needs a constant inflow of energy.



If there is no wind, the windmill can quietly wait for a long time and then resume its only slightly less monotonous existence. If there is no light for a long time, the plants will die. There are various microorganisms that never see light but generate energy from chemical bonds of their substrate. We do the same, obtaining our energy from chemical bonds of the food and oxygen, which puts us under the same pattern as mushrooms (fungi, now regarded as a separate kingdom of life) and some plants that lost the ability to utilize light. This is a very intriguing and relatively underdeveloped topic, which I regretfully have to abandon.

I prefer the windmill to photosynthesis as an ideogram because the latter is **complex** and invisible with the naked eye, while the unpretentious windmill can be seen in all its intimate **simplicity**. Diminished by the threatening complexity of the world, we could benefit from a large type book with pictures to start growing up.

We can see dramatic changes in art and culture over the last century, but what do they mean and where do they lead? We begin to see the repeating alternation of social and political patterns in modern history, but is there any kind of explanation why and when they change and what is their taxonomy? Those are examples of problems I am trying to understand without expectation of any scientific knowledge.

By understanding I mean the ability to discuss such questions in a kind of lingua franca. We understand something when we can share our understanding with somebody in common language and terminology and get the proof of understanding. This process is nothing but the traditional method of teaching and learning by communicating a doctrine, receiving the feedback by asking test questions, giving another round of explanation, and so on until equilibrium.

The multiple choice exam is an imperfect but expedient method of getting the feedback, while a live discussion in a narrow circle of scientists was the decisive way of creating modern physics and chemistry. Starting with molecular biology, however, science acquired the postmodern competitive pragmatism and protective caution. Times have changed and any idea got a price tag.

The difference between knowledge and understanding is best of all illustrated by the fact that we can understand false, fantastic, and ridiculous doctrines, while knowledge, ideally, is either testable or has testable limits. Both knowledge and understanding can be imperfect.

Understanding means a way to consensual knowledge, and if the exact knowledge is impossible, then to a knowledge about its limits and predictive ability. Understanding is

inherently dependent on the language: it is the matter of common language. Ideogram can play the same role as Chinese characters that ensure mutual understanding by speakers of mutually incomprehensible dialects. That was where I got the idea.

Since Aristotle, the traditional way of science has been analysis of a complex object in terms of its simpler parts and features. The synthesis consists in an arrangement of components in a spatial and temporal order.

A complementary way, which is neither analytical nor synthetic, goes from universal patterns to particular configurations. As a scientific method it is hopeless because in science patterns are derived from configurations and configurations from observed images, but it gives a holistic view of the world to be understood. Moreover, it makes possible invention of new configurations (a new kind of potato) and even pattern (genetically engineered fish-and-chips).

Thinking about all that as a chemist, I saw since long a big difference between the way the world was perceived by physicists and chemists. Physicists operate in the realm of continuous values, with the exception of quantum objects, while chemists deal with individual discrete structures. Thus, energy, temperature, and velocity can take any values, while graphs, i.e., combinations of points and lines regardless of distance and angle, do not form a continuous set and do not have any single natural way of ordering similar to the integers, time, or space.

We enter a mixed atmosphere in the physics of elementary particles. The quantum physics, however, deals with statistical ensembles, while there are no statistical ensembles of Shakespeares, Hitlers, or the USAs on November, 2006. There are no ensembles of French Revolutions and Collapses of Soviet Empires, either. All the wars, revolutions, and collapses do not form any ensemble because the numbers are small (hundreds) and the times are different. Yet there could be some way to **understand** revolutions and collapses, i.e., develop a temporary consensus of how to talk about them. Numerous—but not too numerous—attempts have been made.

The difference between the sciences today is as relative and diffused as never before. There is only one science and the habits of segregation stay on the way of understanding. My intent at spirospero.net , therefore, is to explain and illustrate the chemical vision of the world as a contribution to universal understanding.

> Over a quarter century ago, one of my initial motivations to look at the world with chemical eyes was my inability to find a common language with an exceptionally intelligent theoretical physicist who could make any complex topic of physics understandable to me, but I could not explain why I saw big gaps in a physical approach to life and society. Physics was structure-blind and I was tongue-tied.

The new, decisive, and radical step toward developing an abstract mathematical structural vision of the world—a chemical vision of the world outside chemistry—was made by Ulf Grenander in Pattern Theory, to which I have already referred many times. Comprising both continuous and discontinuous deformations of configurations, Pattern Theory bridges the physical and structural aspects of the world in the most abstract and universal way.

I see my role as a freelance explorer of giants and monsters, prodding them with the purpose of proving that they are just windmills, what Don Quixote might have done after reading *Don Quixote*.

I have also another, purely quixotic, idea. The complexity of modern science puts a high barrier on the way toward mass education. I believe that science could be taught in a new way, as **science of everything**, with subsequent specialization along the way. Thus, my seven year old granddaughter studied rainforest at school. In principle, this subject involves all sciences and even politics and is a good syncretic start for a synthetic science of everything. The study of science, however, never becomes synthetic along the way and splits into subjects that, all but one chosen, could only be touched upon the surface, with the substance too difficult and boring for most students, especially, in our hedonistic culture of hurry and waste. The unity of the world is lost.

PART 2. STAIRS AND RAMPS

In Russia I became allergic to Marxism, forcefully fed by it all my life. In America finding a lot of reverence toward Karl Marx initially jarred me. Some components of Marxist indoctrination, however, became ingrained in my mentality; among them class structure and social justice—probably because they were not the monopoly of Marxism.

While clearly seeing a great expanse of inequality in America, I was unsure about the class structure of the country. Such often used terms as middle class and upper middle class seem to float in the air, cloudlike, while the lower class foundation and the upper class roof of the social edifice appeared to be made of a different, heavier and more dense material, constantly in public view, but theoretically inconspicuous. The very first look into American view of the problem told me that the consensus regarding class structure was nonexistent. I saw that as an opportunity to apply, finally, my new mental gadget, ideograms, to the problem within the framework of the strictly individual project a chemist's view of the world, to which the notion of consensus did not apply. The problem certainly looked to me as a giant, and I had to show that it was a windmill.

In this section I give another illustration of what I understand as:

> **Ideogram**: a combinatorial element, pattern, building block, or an abstract feature of X-systems represented (labeled) by its simplest or most common embodiment.

For an expanding collection of ideograms, see complexity and **Essay 47. The War,** where I use **surface tension** as an ideogram. Essays in simplicity contain many examples of distant parallels that can serve as seeds of ideograms. Thus, **Essay 13. On**

Numbers applies the mathematical concept of partially ordered set to Confucian ethics. **Essay 14. On Taking Temperature with a Clock** deals with measuring temperature of music, **Essay 38. On Football** compares World Soccer Cup and American criminal justice.

The very purpose of the notion of ideogram is to use simpler objects as templates for more complex ones.

This is another example of ideogram:

> **Stairs:** an ideogram of an evolutionary sequence of **discrete** structures of increasing complexity emerging on the **continuous** increasing supply of energy.

Figure 3 compares two types of rising structures: continuous (ramp) and discrete (steps).

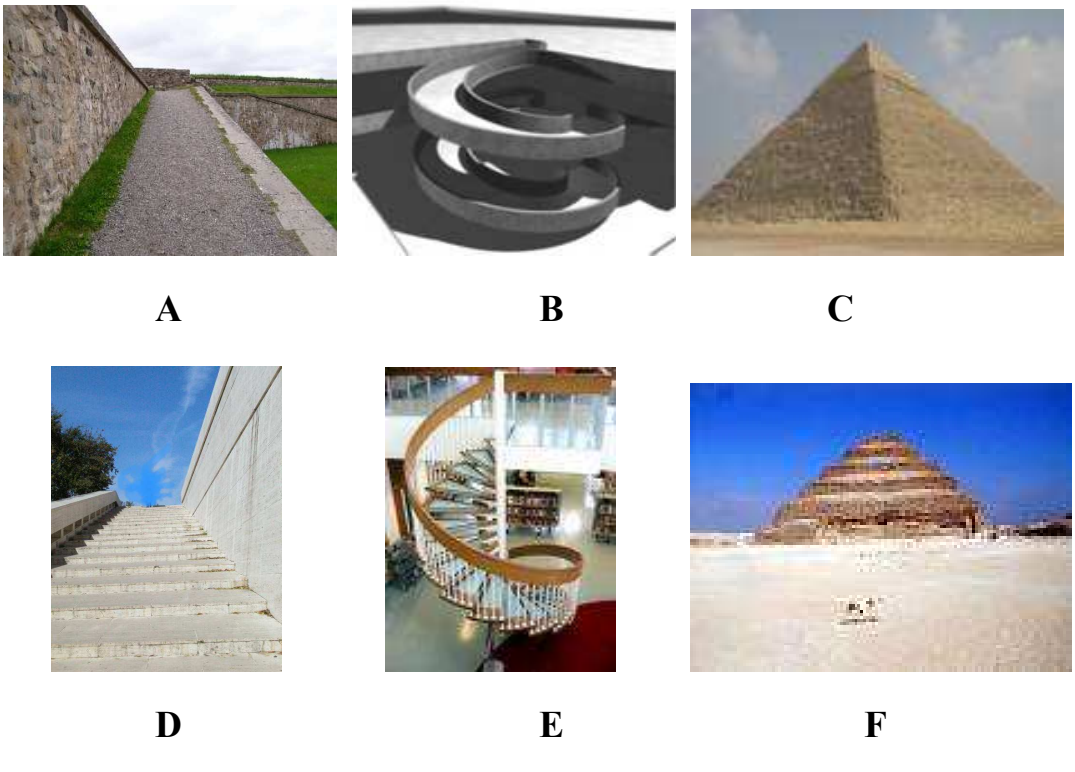


Figure 3. Continuous (**A-C**) and stepwise (**D-F**) vertical mobility

That class structure can be represented by any stepped structure has been quite obvious. **Figure 4** show two out of many variations on the theme.

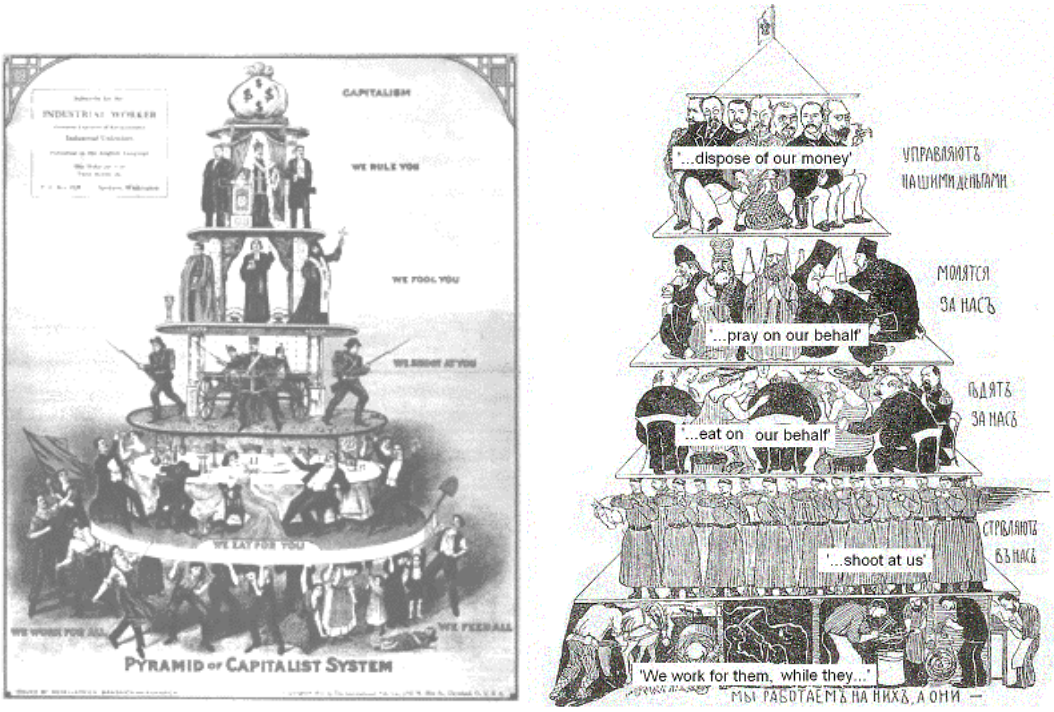
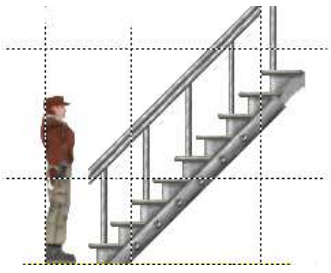


Figure 4. Old cartoons of Pyramid of Capitalist System (A) and Russian Social Structure (B). The layers are labeled, bottom to top: **(A)** "we work for all" (left), "we feed all" (right); "we eat for you;" "we shoot at you;" "we fool you;" "we rule you;" "capitalism" [money bag]; **(B)** "We work for them while they…" "…shoot at us"; "…eat on our behalf"; "…pray on our behalf"; "…dispose of our money".

I remember a different Russian version from a textbook of history, which I could not find on the Web. The lowest and largest level was made up of peasants ("we feed you"), workers were the next ("we work for you") and the czar and czarina were on top ("we reign over you").

Obviously, the American society does not have the rigid social class structure in the sense of **Figure 4**. But what does it have that the economists and sociologists are so confused about?



I choose **stairs** as a version of stepped structures to label the ideogram of class structure.

The man-made things, like biological species and larger taxonomic units, do not have continuous intermediate forms. The reason for that is the discontinuous nature of structural complexity. There are no transitional forms between two different molecules. In short, structural complexity increases when the number and variety of building blocks increases. I symbolically denote a series of increasingly complex objects as the sequence:

1 2 3 4 5

On complexity, see **The New and the Different**, where I suggested two kinds of **evolving** complexity: **difference** (new combination of the same blocks) and **novelty** (a combination with a new block). In terms of Pattern Theory block is **generator**.

Complexity in X-systems increases stepwise. One might say that integers also form stairs of a kind. The difference is that the scale of integers is infinite, uniform, and is suitable for representing continuity, while the steps of the evolutionary scale, however numerous, are limited in number, are all different, and each can represent a very big leap.

> Simplification seems to be as much a property of evolution as complexification. I would take evolution of electronic data storage devices, from magnetic tape to floppy disks, compact discs, and flash memory as an example. I am not sure, however, that a thorough investigation would lead us to this conclusion. The area of structural complexity (understood differently in different areas) has only recently entered a stage of expansive growth.
> See an introduction into the problem: Francis Heylighen, The Growth of Structural and Functional Complexity during Evolution. Search for **evolution of complexity**, **structural complexity**, and **evolution of novelty**.

In **Figure 5A** I arrange five sources of electrical current in order of increasing power, symbolized by pictures of small battery, car battery, ungrounded wall outlet, grounded wall outlet, and industrial switch.

While the scale of increasing current power (resource) is continuous, the complexity of man-made devices is discrete: it has no intermediate forms. Thus, there is no **common** intermediate form between a battery and a rechargeable battery (accumulator), battery and a residential current source, etc.

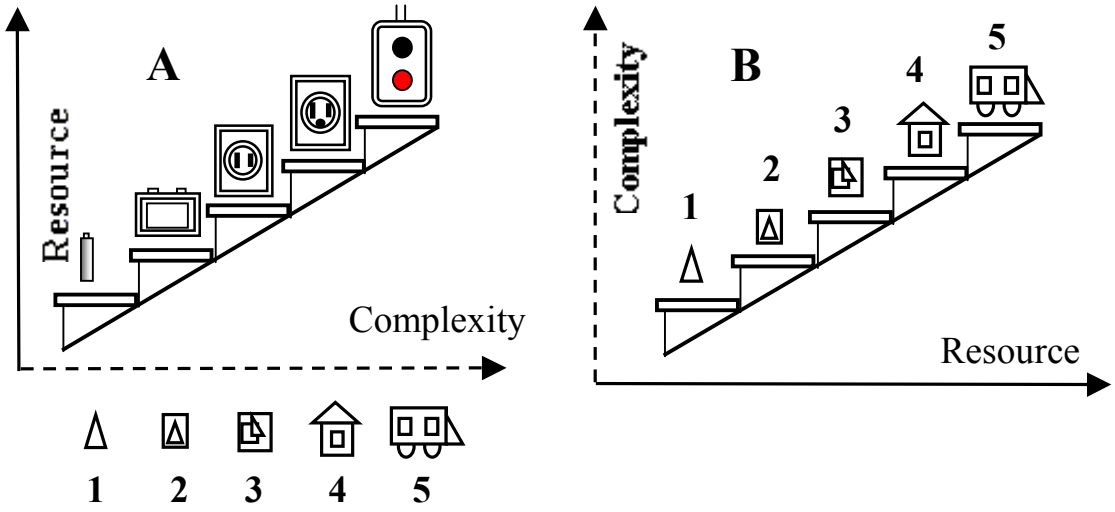


Figure 5. Complexity versus resource

Figure 5B generalizes the relation between complexity and a continuous property, which should not be perceived as a law of nature or any function, either continuous, or defined over a continuous argument, or both. I can only hypothesize—referring to George Soros as a witness—that in the realm of evolving complex systems (X-systems) we should not expect anything exact and definitive. To all arguments of George Soros in *The Age of Fallibility* I add one, in my opinion, most important: **novelty**, which by definition cannot be fully (or not at all? an intriguing question!) anticipated.

The answer to the question how we can develop any knowledge without numerical values is: we can very frequently, if not always, compare any two objects and determine which of them has **more** of some property than the other.

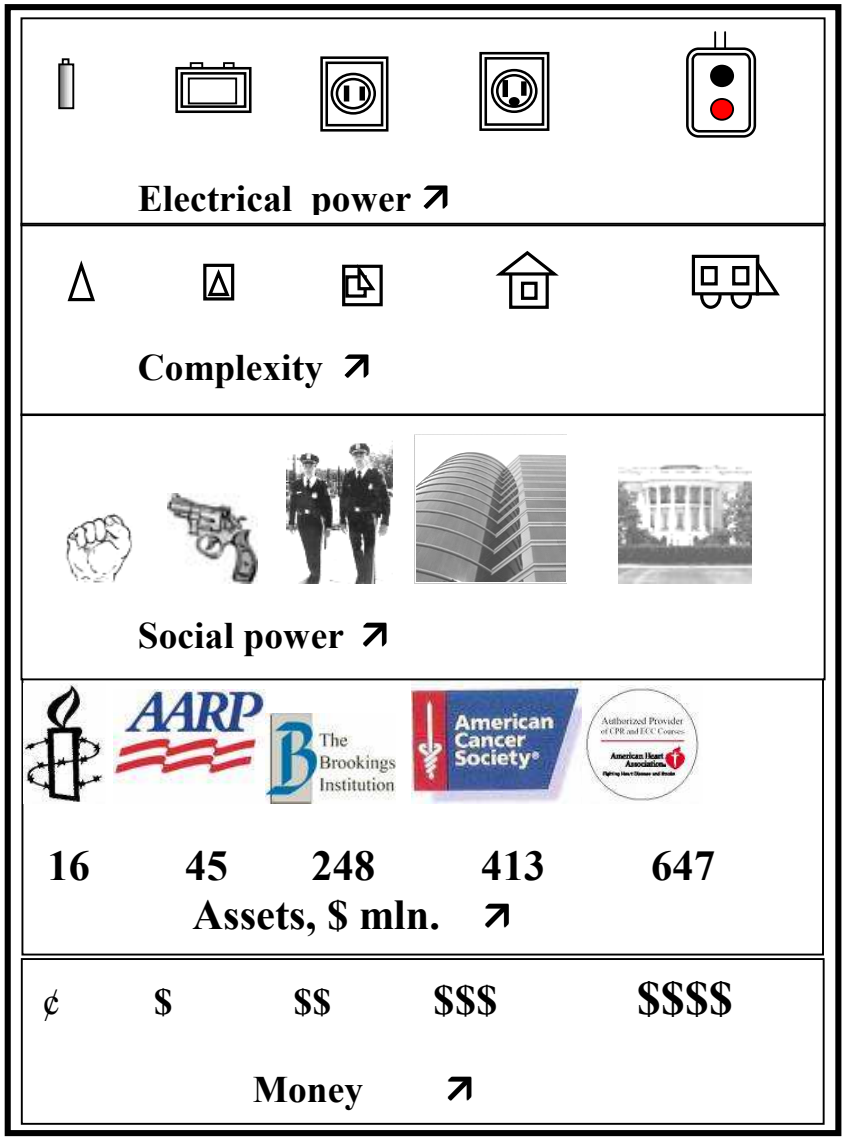


Figure 6. Resource, complexity, and system.
Linear presentation

I do not know how we can generalize structural complexity to fit a universal measure (I believe we cannot), but I know how we can generalize what I call "resource": as energy or money. The latter is a universal systemic currency for social systems and their impact. Biological systems have their own money in the form of ATP (adenosine triphosphate).

Since we are dealing with systems, by energy I mean the energy needed to create a system and to maintain it. This is true about subsystems, even if they are "dead." Without maintenance even Egyptian pyramids will disappear in some distant future. We deny maintenance to our computer—and scores of other things that serve us—by discarding it. We typically cannot deny maintenance to our body, dwelling, and place of work, however. Some systems, like economy, release part of the consumed energy as the production.

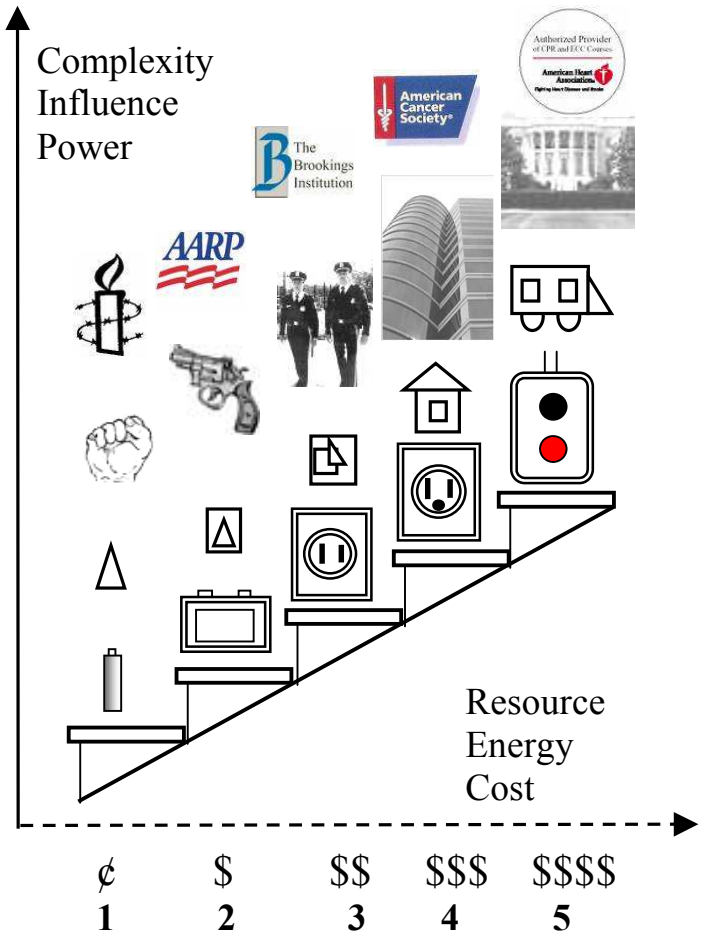


Figure 7. The stairs of power

Figure 6 gives more examples of stepwise increase of complexity and available power: fist, gun, armed group, corporation, and White House, as well as five American non-profit organizations: Amnesty International, American Association of Retired Persons

(AARP), The Brookings Institution, and American Heart Association, in order of their cost or budget (source: Capital Research Center).

Figure 7 illustrates the relation between complex systems and their common resource. It also shows that the power of a system, i.e., its ability to function in a larger system, depends on its complexity and the latter depends on the original resource. Figures 6 and 7 illustrate the great range of power.

A subsystem of an X-system is, therefore, a transponder of a resource into usable and dissipated forms. Power is the ability to provide and **allocate** the resource. Thus, a corporation or an individual who donates money to a non-profit organization (or pays to a hired killer) provides the resource and trusts the recipient with its allocation.

What does it mean to allocate the resource? A chemist imagines the final result of an experiment, which is **always** possible in chemistry because of its closed generator space (i.e., the atomistic Periodical System), and moves toward it with a significant expectation of success, employing the enormous and ever growing chemical knowledge. A failure often leads to a **new** knowledge. Usually there are many possible ways to a goal, and if one ends up in a blind alley, another may bring more luck.

A politician can see the final goal, but the goal can be very schematic and the knowledge illusory. A businessman is in a better position because of the available body of knowledge, which does not guarantee a success. But the political knowledge in our impetuous time is more illusory than anything else.

> Nevertheless, many politicians are sober and realistic people. They understand that the more ambitious the goal, the more time will it take to reach it. Meanwhile, the politician can achieve a smaller, but more attainable and more selfish goal.

I have neither qualification nor intent to go any deeper in this subject. All I want is to express the idea of the **discrepancy** between the **continuity** of resource and the **stepwise** evolution of man-made systems.

Next I will try to encroach upon a completely alien to me territory of the actual class structure in modern capitalist society.

In **Figure 8** only the abstract complexity and resource are left.

The chemical picture of the world requires me to modify the design of the social stairs by adding a transition barrier from one state to the next—a universal property of every change and one of the few main tenets of chemistry. Very approximately, I see it as the one-time additional quantity of resource (initial investment) needed to create a system of a higher complexity, which will, hopefully, sustain itself.

> I wish to emphasize that all my judgment regarding economics and finances (as well as numerous other subjects) is strictly amateurish and generously augmented with creative ignorance.

What follows from the above view of the problem is the **illusory character of a classless** (in economical sense) society. One does not climb the small numerous stairs, a dollar a time, to the next floor. To put it differently, here is no social ramp to the top, although, as biographies of some future billionaires testify, a kind of a ramp leads to the first step. To ascend further, one has to enter an elevator for a fee, **Figure 8**.

The limited character of available at any moment resources changes the simplistic realtion between complexity of the goal and the resource. The higher one rises, the higher the elevator fee, **Figure 9**.

Figure 8, however, misses the most important property of the distribution of wealth and. probably, all specifically human values: the higher, the more rare. This class of distributions is known as **power law** and under various names depending on the area of application. Wealth in capitalist societies is distributed along **Pareto distribution.**
For our purpose we can interpret the dustribution as in **Figure 9**: each next step of the complexity ladder is higher than the previous one. This does not directly follow from the Pareto distribution, but, probably, explains it. The common perception of life is that the beginning is difficult and the top is hard to reach. As far as the distance between the first and the last steps, it seems like a ramp. **Figure 9** metaphorically represents this illusion of the beginners, most of which will end up in the middle, clinging on to what they see as the slippery ramp.

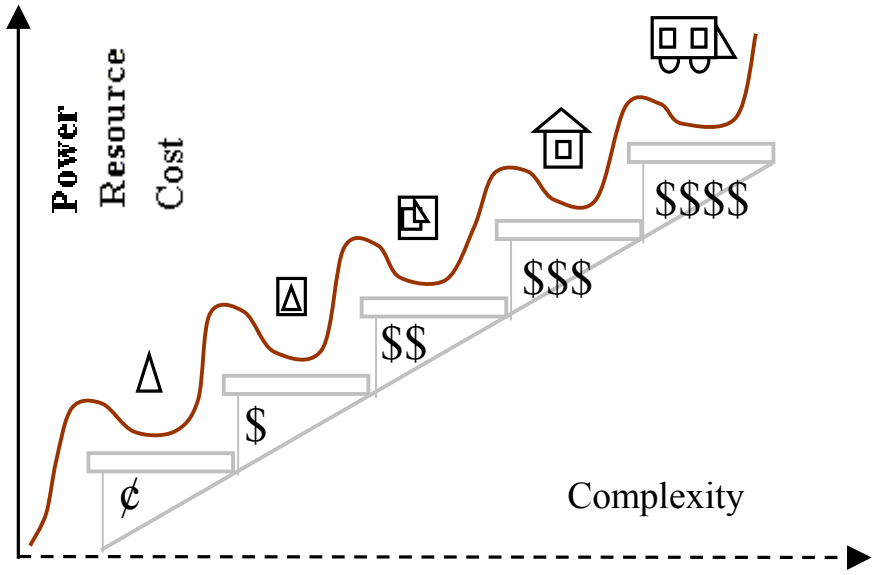


Figure 8. The chemical view of vertical mobility. **The stable positions are local minimums of cost.**

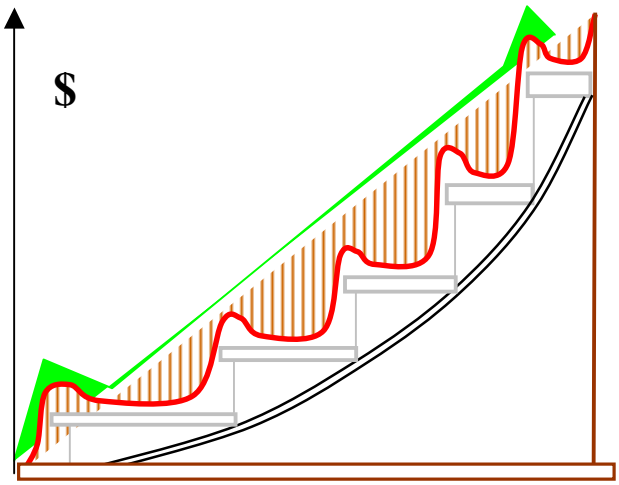


Figure 9. Increasing price of power and complexity

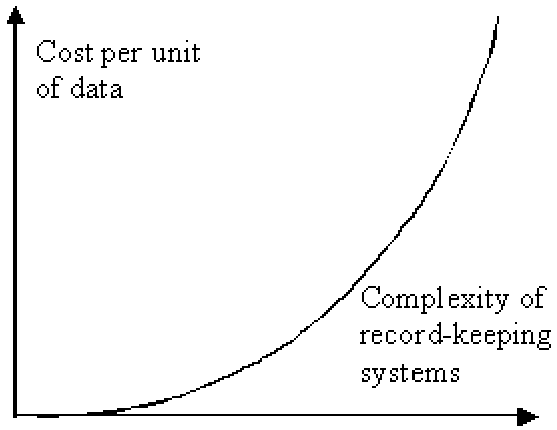


Figure 10. Cost of complexity

A casual illustration of the cost of complexity is given in **Figure 10** borrowed from: **Eljas Orrman, Structural Complexity of Electronic Records as a Factor Guiding Decisions on Permanent Retention.** The paper deals with the problem of costs and benefits in archival storage of electronic data records. The author does not specify what complexity of a record means and simply states that "The more material with a very complex structural form is taken into permanent/long-term preservation, the faster will the cumulative costs grow."

I believe that complexity of modern society and its documentation is one of the major perils of democracy. The US Tax Code or congressional appropriation documents

unreadable because of their size are best examples of complexity for which **mad** or **insane** seem to be exact scientific terms and **Byzantine** too far off. This is one side of the problem. The other side is that there is no reason to expect the understanding of extremely complex problems from the elected officials, candiadtes, and the voters with the ever pressing election needs. Two years between American elections is to short a term to understand the problem and long enough to lose the control over fast pacing events.

I am going to add another example because of its intense eloquence.

> Source: **Steve Burbeck. Complexity and the Evolution of Computing: Biological Principles for Managing Evolving Systems (2004).**
>
> Complexity in the digital world is beyond our control….
>
> Computing systems are seldom *designed* these days, they *evolve* and as they do so they become ever more Byzantine and complex. …
>
> Civil engineers who create steel bridges have a saying that "rust never sleeps." The comparable maxim in computing ought to be that "complexity never sleeps." And, once complexity is out of control, it takes control. Computing professionals work tirelessly to reduce complexity but all too often their efforts actually exacerbate it because the already complex systems are far beyond our comprehension. …
>
> IT professionals expend substantial resources detecting and cleaning virus and worm infections, patching machines, modifying firewalls, updating virus detection software, updating spam filters, and the like. …

CONCLUSION

My investigation of class structure in America should not be taken too seriously. My main intent was to add another couple of examples of ideogram as a tool of understanding the world which is commesurable with our lives and observable directly, without either telescope or microscope. The **stairs** are a simple thing, Dopey among the Seven Dwarfs. Widely used as a metaphor, it labels, however, an important pattern of many not completely understood X-systems and is chosen exactly because of its simplicity and observability. So is **windmill**.

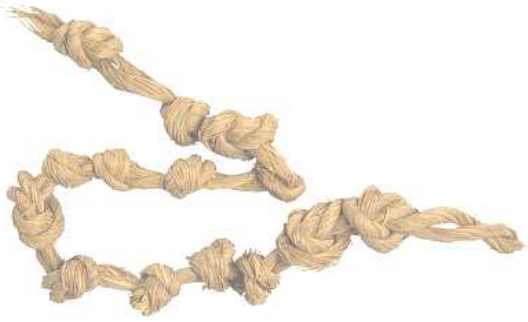
I have omitted here many important points and references. More than half-seriously, I believe that there is no use of a complexity treatise which is more complex than complexity itself.

The Marxist indoctrination did not make me a Marxist, but it imparted on me a lasting interest in Hegel, who was regarded, along Lenin, as one of three sources of Marxism.

I conclude this essay with a wonderful ideogram Hegel used for the inherent discontinuity of devolution: knotted rope ("knotted line").

> This process of measure, which appears alternately as a mere change in quantity, and then as a sudden revulsion of quantity into quality, may be envisaged under the figure of a nodal (knotted) line. Such lines we find in Nature under a variety of forms. (Hegel, *Encyclopedia*, $109)

Here it is:



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