A hands-on, layman view of complexity

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Abstract

A simple, outspoken approach is chosen to introduce the concept of complexity, with the goal of demystifying and sorting out the fog of contributions to this grand subject by the many disciplines involved. To this end, the emergence of complex thinking is described along the knowledge development of an individual, as opposed to the history of philosophy and science. Coherently, a communication based on clear, albeit approximate, indications is preferred to intricate, all encompassing descriptions. What might have to be done about some practical issues is also preliminarily investigated.
The article is addressed and dedicated to the readers who got in touch with the above indicated fog [purposely, no bibliographical reference is provided] and experienced difficulties in finding a clue about how to make some sense of it all.

Keywords: knowledge modelling, layman view, thinking evolution, variety generation.

Everything is connected with everything else...

1. Introduction

The many disciplines involved in dealing with complexity have built such a large body of knowledge so far, that a dense fog of contributions now clutters a possible layman's view of this important concept.

This article, therefore, is meant for those who'd like to know – in compact terms – what it might be all about.

2. Preview

This introductory section sketches the role of some secondary subjects, relevant in this attempt to synthesize the work of many diverse disciplines into a simple description of complexity.

The subjects briefly previewed are:

2.1.Modelling / learning.
2.2.Language.
2.3.Simplicity.

2.1. Modelling / learning

The discussion purposely starts from "knowledge modelling", a prominent subject within the overall notion of learning / knowledge building / mind changing, according to the following scheme:

- It all starts with some "structure" (a model, even unconscious, or a working hypothesis).
- Then, some "data gathering" is performed (from cold memories, hot senses about experiences, studies, etc., i.e. life, or purposeful measurements) and the gathered data are duly placed into the above structure.
  This is *additive* learning, providing *incremental knowledge*.
- When the incoming data are in serious disagreement with the structure at hand, this is redefined, or changed.
  This is *deep*, *real* learning / so called *"paradigm shift"*.
- Eventually, all the above is made *conscious*, *continuous*, *open* (e.g. to other models / models of others), thereby making it *flexible* / *adaptable*.
  This is possibly Morin's "method", i.e. *learning to learn*.

According to the above scheme[1], a model performs an all-encompassing role:

- It provides previous knowledge (if any; otherwise, a proper repository for incoming data).
- It supports the learning process.
- It's the very purpose and subject matter of learning.
- It holds the incremental and the resulting knowledge, acting as the "very object" of the learning activity.

The models used in the indicated learning modes – incremental; paradigm shift; learning to learn – could be pictorially described, respectively, as:

- A "container", progressively filled-up, similar to the Zen tea cup, which needs to be emptied in order to be filled-up differently or anew (filling it up "again equally" would be pointless, ...except for a good tea, of course).
- A "network", capable – *in lumps* – of changing

[1] The value of the scheme, if any, lies in the fact that many people allegedly "learn" *just the other way round*:
. Without a starting "structure".
. With dispersed, unconnected data gathering.
. With a rigid and "closed" model, if any.
. With all the process performed in an unconscious, fragmented and/or poorly flexible / adaptable way.

shape, internal structure, external connections, dimensions, ..., in order to fit with any relevant, external or internal objective and/or constraint (i.e. powerful, agile and unpredictable enough to entail conceptual revolutions).
- A *consciously* and *purposely* learning network, *willing* to *continuously* evolve / revolutionize itself.

It is the evolution of learning, with growing flexibility, adaptability and intention when moving further from mode to mode.

Notably, learning:

- Can improve both its object, i.e. knowledge, and itself.
- Is the [self-provided] tool used by humans to progressively change their minds and perspectives from traditional to complex thinking.

Notably again, each learning mode readily makes the previous one(s) trivial, in a sort of "pre-eminence of what's next", which appears to have extended validity:

- For learning "methods" [e.g. open models evolve in a much faster and richer way than closed ones].
- For key learning "contents" as well [e.g. each paradigm shift sheds new light on previous thinking(s), which are reshaped and inserted within the novel, wider perspective as just local, specific cases].

There are strong indications that some sort of "smart" learning / "deep" understanding is required to tackle a complex subject, together with some powerful supporting tool:

- Studying a complicated systems model, with many interconnected feedback loops, is just difficult in itself. Imagine how hard it may be to explore complexity, in its declared *interconnection of everything with everything else*. It's just like running after the mythical turtle, ...but a very fast, and ever accelerating one, in this case [not differently from the cosmological models which try to encompass an expanding, and ever accelerating, universe].
- Complexity nears infinity, e.g. there are 10 elevated to the 200th power possible different proteins; with such potential variety [actually implemented just in a tiny share], how large biological diversity could be generated? Understanding complexity requires some serious "overcoming capability" to eventually catch ...a "warp speed" turtle.
- A smart enough learning capability (a real desire to run) is therefore needed, as well as some powerful supporting tool, capable of helping us run as fast as needed:
  . As regards the former, a "truly open" learning approach (as indicated above) is required to understand complexity, which is "open to change and variety" (as it will be seen below).
  . As regards the latter, luckily enough, and since long, we do have our Achilles[2], the hero capable of carrying us on his shoulders while chasing the turtle at mental warp speed...

2.2. Language

Language can represent anything; anything humans may conceive. Tautologically: how would you express something you think, if not in language?

There are concepts people go crazy about. Cantor went literally crazy about infinity (everybody would, trying to do what he did). One can say or write "infinity" and "infinite" at will, in relationship with an infinite number of subjects. If you deem it impossible, since human life if finite, this readily shows that everybody can "write" something so huge to be impossible even for the whole mankind to perform.

Language may not prove everything (damn Gödel...), but it's really "powerful", i.e. it can "speak" anything conceivable. It would be hard to say whether [complex] mind came first, and then language, or the other way round. Within a complex perspective, the question is kind of pointless: not only "everything is connected with everything else", but *things are co-generated / co-generate themselves, reinforcing each other*, too.

To make a long story short, language is our Achilles, the hero that can bring us to infinity much faster than the speed of light [in our case, the right support required for our smart learning]. However large complexity may be, however large the ensuing variety may become, however fast our "warp speed" turtle may run and accelerate away..., in any case we can catch it, and describe it in some language.

In order to describe complexity, language is, simply, the key.

2.3. Simplicity

"Simplicity is the ultimate sophistication."

Leonardo da Vinci

The sheer power of language allows to shrink a description of *"***C***omplexity"* into three dense, astonishingly simple words: *"***e***ndless* **v***ariety* **g***eneration"*.

The complexity "formula", therefore, is "**C** = **e v g**" ['**C**' is capital, since it's a "large" concept; '**e**', '**v**' and '**g**' are small, since they are "tiny" generators].

"Generating simplicities" are widely exploited tools. The Fibonacci's numbers, which start with 1 and proceed further by building on themselves with no limit [each one is the sum of the preceding two: 1, 1, 2, 3, 5, 8, 13, 21, ...], help mother nature to

[2] It purposely sounds "ancient Greece": complexity is in the realm of philosophy, not of technology.

generate many of its patterns. Equally:

- Three simple concepts, '**e**', '**v**' and '**g**', are bringing, not trivially, the whole universe to [unpredictable] infinity.
- For the sake of precision and, possibly, completeness: *"**C**omplexity **e**ndlessly **g**enerates 'blind' structural and behavioral **v**ariety, ...just for **evg**'s sake."*

Language kept its promise. Achilles overcame the turtle. We got hold of complexity.

...Did we? Maybe, we just touched it.

We are running too fast, and not seeing the landscape is the price we pay when travelling at maximum speed, and beyond.

But there's a benefit, too. The journey can be reviewed from the destination, a key vantage point in understanding.

3. Theory

The above description could not be developed in its full "generative" meaning without the work – to be individually and collectively credited and honored – performed by scientists and philosophers on the whole "mechanics" that lies behind complexity.

We will discuss:

3.1 Philosophy.
3.2 Science.
3.3 Real life.

3.1. Philosophy

Philosophy comes first, given the following belief:

Philosophy without science is useless,
but science without philosophy is blind.

In the first place, *chaos* generates **variety** of *behaviors* on its own.

This happens according to:

- (Simple,) non linear mathematical laws.
- "Bifurcations" / large changes in output for infinitesimal changes in input, due to these nonlinearities.
- (Strange) attractor-driven dynamics, capable of "exploring" large sections of the phase space.

Then *complexity* leverages on chaos.

An endless **variety** of *structures* is generated, starting from a primeval fractal broth [where everything may connect with everything else...], in a sort of "automatic" mode – autopoiesis (i.e. self generation) from autocatalysis (i.e. self reinforcement) – by *blindly exploiting*:

- Variety of behaviors / "exploration" of phase space, from chaos (as indicated).
- Widespread presence of self-reinforcing feedbacks, amenable to fasten together into autocatalytic cycles.
- Favourable power law [or similar] statistics (from interdependence)[3], capable of readily activating viable autocatalytic cycles[4].

Generated structures are layered and hierarchical, with positive feedbacks operating also between layers, according to the most intriguing characteristic of [some] autocatalytic cycles: *downward causation*[5].

At this stage, variety generation spreads wildly / becomes "ontological":

- On the one hand: arrow of time, self-organized criticality, life, representation, cognition, learning, consciousness, history, society, ..., politics, economics, finance, ..., art, ...
- On the other hand: evolution, natural selection, "fitness", ...

In the end, everything is explained by:

- *Endless "blind" structural variety generation*.
- *Downward causation*, capable of co-generating multiple layers (i.e. "bootstrapping" the generating layer below by the generated layer above).
- *Downward perception*, pushing humans to attribute purposefulness / meaningfulness to a mere variety generation for the sake of itself, which – since it includes interaction and competition [which in turn provides selection and evolution] – elicits a perception of "fitness" which, however, is utterly fake: *the survivor is "fit"* (**tautology**), *not the other way round* (**teleology**).

This picture of complexity is different from other views for its overall simplicity and also a number of small "deviations" from some usual wording / concepts (possibly linked to Darwinian thinking):

- The sentence "evolution by natural selection"

[3] A Gaussian distribution describes the behaviour of a set of independent phenomena. A power law [or similar] statistical distribution, with s.c. "long tails", appears when individual phenomena become increasingly interdependent / the system components increasingly interconnected.

[4] To activate an autocatalytic cycle (a set of loops which self-sustain as a whole), the system has to "explore" its possible states, to find one which "activates" the cycle. In this scenario, chaos provides the "exploring capability", while a power law (with "longer tails" than a Gaussian) provides large chances of activation.

[5] On one side, each layer operates on its own (our mind "thinks", our neurons work according to electrochemistry; a psychiatrist would care of the former, a neurologist of the latter). On the other side, a baby may "think" to put his fingers into a electric power outlet, thereby inducing (possibly fatal) effects on its electrochemistry; in a less dramatic way, "downward causation" is the effect of an upper layer on a lower one.

should be changed into "evolution by variety generation and natural selection" (variety generation is needed by evolution).
- Actually, variety generation readily includes evolution and selection:
  . Selection results from [competitive] interactions within the generated variety.
  . Evolution is the outcome of variety generation and selection.
- The terms "fitness" – and possibly also "selection" – should be treated suspiciously:
  . The former is customarily linked with some form of teleology.
  . The latter has some teleological "smell" as well [using the word "interaction", instead, might prevent this risk without damage].

Variety generation is just mother nature at work; it entails a simple, yet general view:

- First, *variety* [in the broadest sense] is generated.
- [Co-evolving] *interaction* within the generated variety provides so called "selection": what *survives* is called "fit" [as a tautology].
- Despite selection and alleged fitness, variety [in the broadest sense] *always increases*.

The central point in complexity is its infinite generative capability, which Darwin first surfaced and here bursts in the very center of the [universal] stage:

> *Were I God, I'd start from a variety generator to create the Universe.*
> *And then I'll let humans try to make some sense of it.*

And all the rest are [better or worse] human approaches to make sense of reality:

> *Were I Adam, ...I'd start to learn.*

3.2. Science

As regards complexity, science is in a worse position than philosophy:

- In the latter, we can "touch" the turtle, by "exploiting" language.
- In the former, we can't "get hold" of the speedy animal at all: ...language isn't enough, here.

For "traditional" science – deeply rooted in "foreseeing" / "foretelling" / "anticipating" – complexity entails a deep paradigm shift, with striking similarities with the revolution brought about by quantum mechanics:

- In quantum mechanics, we have statistics deeply rooted in the micro-machinery of reality; in complexity, we have (positive) statistics at work in much larger environments.
- In the former, we have uncertainty; in the latter, emergences.

For science, Hector – Achilles has done his philosophical job, already... – may do three things:

- "Make science", i.e. develop models, from explanatory to operational, trying to get hold of the turtle (but it runs fast, so fast, ...and ever faster).
- In case the above proves difficult, "make philosophy type 1", i.e. debate about the conceptual possibility of getting hold of the turtle on a scientific ground.
- In case this too turns sour, "make philosophy type 2", i.e. describe the situation.

Exploiting the vantage position of reviewing the journey from the destination [or, more pictorially, ..."back from infinity"]:

- "**C** = **e v g**" is the compact description of the situation ("philosophy type 2").
- The sheer, intrinsic, "ontological unpredictability" of variety generation rules out the "philosophy type 1" conceptual possibility of "scientifically getting hold" of the turtle.
- This, in turn, makes the scientific attempt [conceptually] vain.

Overall, the role of science in complexity seems to be limited just to analyzing its "mechanical" details by modelling subsystem, with apparently no chance of modelling the [ontologically unpredictable] whole.

3.3. Real life

How do we deal [conceptually] with complexity? Some indications are provided below, about:

- The possible modelling development within an individual.
- A possible categorization of thinking paradigms.

Modelling development within an individual
Modelling develops within an individual approximately in this way:

- A baby is born with a[n unconscious] starting model which connects the-baby-and-its-mother in an undivided unity (by the umbilical cord, when in the womb; then, by breast-feeding).
- Of course, this "model" is progressively challenged by [sensory] inputs from the external world. The baby progressively realizes that it can control its own body but not those of the other members of the family (although, in the beginning, it could make all of them come near, ...by crying).
- Eventually the baby builds a separate represen-

tation of self, vs. the world first, and then vs. its mother[6,7].

- A youngster, in the course of his/her life, develops a more or less "linear" model (i.e. cause-effect) of the world, of which an inevitable component should be the consciousness of the self as "separate entity" from the connections / relationships / representations he/she develops about the rest of the world[8].
- To make a long story short, during life – first with the interaction with school (and a certain type of culture), then with society (and another type of culture), further with profession (and a further type of culture), etc. – an individual evolves his/her own mental models, whether they are reductionist, systemic, holistic, complex, or else, within the course of a – partial or complete – evolution of his/her learning capabilities towards true "learning to learn".

Shortly:

- The baby "creates self", out from an interconnected world.
- The adult starts form self to meet a "world of interconnections".

Categorization of thinking paradigms

Thinking paradigms can possibly be categorized in the following five step progression:

- *Linear* thinking (from cause to effect): finding the laws which link effects to causes; identifying interesting causes which generate interesting effects; forge effective / efficient causes to obtain the desired effects.
- *Systemic* thinking (the effect feeds back into the cause; systems have states; systems may reach eventually an equilibrium): finding the laws which describe the behavior of the feedback loops, with specific focus on the stability issue; finding the laws which describe the behavior of systems, as a function of inputs and states; describing a system in terms of feedback loops, states, transfer functions; modelling systems in order to simulate their behavior; designing systems which exhibit the desired behavior.
- *Complex* thinking (everything feeds back into everything else; non-linearities are rather the rule than the exception; of innumerable feedback loops, most are intrinsically self-reinforcing): finding the general laws which rule the system as a whole (chaos, order, life); identifying possible "attractors"; spotting when a real system exhibits a "normal" or a "complex" behavior, and adjusting the analysis paradigm accordingly.
  At present, complex thinking is ..."divided"; there are:
  . People who study how the parts interacts, in order to "generate variety" (emergences, self-organization, life, ...) and other people who take a holistic stance, which starts from the whole, instead.
  . "Scientists" who keep modelling and modelling all the time – and so better belong to systemic thinking – and "philosophers" who rather consider the "ontological difficulties".
  . People who think diversity (e.g. biological) is a value (e.g. for resilience: if dinosaurs die, mammals are left...) and other people who think in some cases some intervention shall be done to simplify things / make them more dependable, instead (e.g. in the financial system).
- *Synthetic* thinking (everyone holds just a partial model of the laws which rule the system behavior): putting own perspective into discussion within a dedicated team, in order to discard own "silo / reductionist views and assumptions"; reaching, in a joint effort with others – with tenacity, energy and hard work – a shared, comprehensive, effective, higher-level perspective (indeed, there's little, or even nothing, more intellectually satisfying).
- *Simple* thinking (reality is one; life is research): meditating, and reaching awareness / enlightenment, personally and/or in relationship with others.[9]

[6] Another important part of the baby's growth starts as well, related to family's love and care, which counteract the "inevitable separation" of the baby from its mother. It will not be discussed here.

[7] Possibly, learning and consciousness emerge roughly together. Notably, a key element for these emergences should be the body, somehow needed for the mind to develop: hadn't we a body, our mind might probably find difficulties in recognizing itself (most likely, body consciousness precedes mind awareness).

[8] Consciousness is envisioned to emerge "very soon", and then evolve:
. Initially, as "distinction" of own body (the part of the whole somehow under own direct control) from all the rest (the part of the whole beyond control).
. Progressively (probably through memory, which "carries reality along time"), as "distinction" of own thoughts (somehow under own direct control) from others' thought (those beyond control).
. Eventually (if hopefully some sort of collective conscience is born, e.g. care for the common good), as capability of sharing own thoughts with others, without losing own identity.

[9] The value, if any, of indicating these steps is that many people may actually "stop in between":
. Many people still think in *"linear"* terms, and do not understand anything systemic (Nassim Nicholas Taleb – and George Soros, with his "reflexivity" – repeatedly warn us about the fact that our politicians do not understand the reality we presently face...).
. Those who think *"systems-wise"* not always understand complex issues: an example are "more-of-the-same" modelling attempts (cybernetics lies in between; a good reading would be Principia Cybernetica Web: http://pespmc1.vub.ac.be/TOC.html).

As regards specifically "synthetic thinking", it's a kind of an approach for every season, which opposes the largely diffused "silo issue" in organizations / reductionism in academy. On the practical ground, it can be considered as a short-term way-out from some complex issues:

- It blends a "classical" part (design objective; management scheme) with a "complex" one (open approach; emergence of a "mind-of-the-group"). The latter – the value of which lies in its intrinsic capability of overcoming silo / reductionist thinking – still leverages on a management element, i.e. the quest for systematic listening, a pre-requisite for building real connections within the team.
- Its results / emerging solutions usually tend to lie "on the simple side", with some direct / straightforward "synthetic" understanding, which frequently puts problems into a novel perspective that makes them "false".

4. Practice

How do we deal [practically] with complexity?

- Complexity really "explains" a lot, more profoundly than ever before, in science and philosophy: all the wealth of variety around us, from the infinitesimally small to the infinitely large, is sort of accounted for by the infinitely numerous, therefore becoming "meaningful" [...as much as "variety for variety's sake" can be].
- However, complexity seems to help very little in finding out what to do... At present, most solutions still tend to be in the areas of "systemic" or "synthetic" thinking, respectively about problems which somehow can be modelled, or – on the contrary – are better tackled with multiple perspectives brought to bear together.
- On the other hand, there are a couple of areas where problem solving approaches, truly based on "complex" concepts, are emerging:
  . One is just a smarter way of exploring the solution space (e.g. genetic algorithms): a good and useful choice, intriguing too, but conceptually still limited vis-à-vis the grand subject of complexity.
  . Another area is about a set of [possibly counterintuitive] indications, very useful in helping not to make [philosophical] mistakes in problem solving, which could be synthesized as a paradigm shift from *devising allegedly sufficient solutions* to *ensuring the necessary conditions* for the required outcomes to emerge on their own [however simple, and possibly obvious, this concept may be, it entails a profound change in the existing problem solving culture].

A subject characterized from the very start by *everything is connected with everything else* faces the unavoidable challenge – very close to a conceptual mistake – of choosing some subsystems for a more detailed discussion, the result of which will inevitably be "partial", both in domain of interest and in soundness of proposed standpoint / solution.

This "forced" choice has landed on some "hot" subjects in the discussions about complexity, with just preliminary indications provided for each:

4.1 Management.
4.2 Systems.
4.3 Society.

4.1. Management

There's possibly excessive fussing about organisation and management, due to the fact that complexity is "in fashion":

- The best approach heard so far about organizations is a kind of "plural" management, leveraging on teams [which the author suggested more than 10 years ago to an Italian automotive manufacturer – guess which – ...without any connection with complex thinking at all].
- Complexity, by and large, is a new paradigm, "orthogonal" to traditional, quantitative managerial approaches, which require a different, much less "affirming" mindset [again, not so different from the "provocation to rethink", which used to drive organization / operations redesign and should now be widened in scope]:

. Those who think *"complex"* ("How we can think the complex": http://pespmc1.vub.ac.be/Papers/ThinkingComplex.pdf) explain a lot, but find difficulties in providing immediate, effective solutions: if reality "generates variety" and therefore is (ontologically) unpredictable, there's not much to rely upon.
. Those who apply *"synthetic"* thinking appear as dull practitioners, but there's "good philosophy" within that too: team members, which "know parts" of reality, are just "everything a team can have"; merging their 10-20 minds into a single "mind-of-the-group" provides very large chances of not making mistakes, which today would be a significant achievement (true adult learning is not about adding new knowledge elements, but about discarding old assumptions / superstitions, coming from all thoughts dedicated in own life time to poorly known facts and/or disciplines); synthetic thinking may be at a lower conceptual level than complex thinking, but that's the best one can have from an "operating" point of view (given the ontological limitations of complex thinking); not least, in its discarding old assumptions / superstitions, it's the [western] forerunner of simple thinking.
. *"Simple"* thinking belongs to those who "understood everything", usually mystics or enlightened persons; there are also great scientists and philosophers who "understood everything", but they seldom provide simple indications about it [cfr. the "fog" made about complexity...]; and even the few who try to send simple messages according to Murphy's law will find audiences with "complicated minds"...

"When agents in an organisation accept at least some notion of complexity, they tend to reduce the amount of planning, substituting this with preparing for the unexpected. In practise, this could be done by shifting focus from schedules and plans (representing a 'mechanistic' approach that tries to predict the future through analysis) to core values, long-term goals, do's and don'ts, human relations and so on. Even a minor insight in complexity helps this transition in agents' worldview."

Rasmus Dahlberg

"In a sense complexity thinking is about limits, limits to what we can know about our organizations. And if there are limits to what we can know, then there are limits to what we can achieve in a pre-determined, planned way."
"Complexity thinking actually requires us to spend a little more time thinking, and a little less time working."
"...for complex systems - by which I really mean any part of reality I care to examine - there exists an infinitude of equally valid, non-overlapping, potentially contradictory descriptions."
"The result of these observations is that to have any chance of even beginning to understand complex systems we must approach them from many directions - we must take a pluralistic stance. This pluralist position provides a theoretical foundation for the many techniques that have been developed for group decision making, bottom-up problem solving, distributed management; any method that stresses the need for synthesizing a wide variety of perspectives in an effort to better understand the problem at hand, and how we might collectively act to solve it."
"Fragmentation is inevitable, but what we must learn to do better is work with this fragmentation rather than force a 'commensurable unification' upon it. Efforts to this end are readily apparent with the current trend for cross-disciplinary and multi-disciplinary research. Such research will always be difficult and will not be overcome by pushing for a unifying framework, which will do little more than paper over the cracks (and in so doing severely limit our opportunities to develop richer understanding)."
"Complexity 'thinking' is the art of maintaining the tension between pretending we know something, and knowing we know nothing for sure."
"...I'd like to discuss briefly why I believe philosophy is important for organizational managers (and every sophisticated thinker for that matter). I hope it is already clear that I believe complexity science itself suggests the central importance of a philosophical attitude when considering the world we experience."

Kurt A. Richardson

Boiling down things to [simple] nuts and bolts, most probably the issue of complexity in management should be divided into two, very different, chunks:

- The external complexity, a real issue.
- The internal complication, just a wrong response to the above.

A possible – "systemic-synthetic" – solution would be to:

- Slash the part of the internal complication which is outright silly [e.g.: the silo objectives; the cumbersome controls structures; the latest organizational fad; the dismal link between user requirements and IT late-risky-rigid-possibly wrong delivery; the wrong approaches to reengineering; ...]. Here, a user-driven, continuous-or-radical process improvement / change capability (ICT included, of course) could kill in a single move all these bad examples.
- Once the above has been done, have a number of "diverse" people continuously interface, and discuss, at different levels, about the external issue, with the advantage of being possibly freed from the internal one [not by chance, Ashby's theory is about requisite "variety"...][10].

This possible solution, at least:

- Does not respond to complexity with (useless) complications.
- Does not cumulate (useless) complications over complications.
- "Ecologically" links people and ICT (the former think; the latter executes, in a flexible and dependable way).
- As it's used to say when playing bridge, "doesn't harm".

Not trivially, these four indications could be a good set of test criteria for other approaches...

4.2. Systems

A "system" is a set of elements or parts interlinked by reciprocal, possibly cooperative, relationships. Let's start from identifying possible categories:

- A *"designed system"* (by man, by some animal, or even by an IT application) is usually [there are always some exceptions...] characterized as follows:
  . It's made to perform, with various levels of

[10] Notably, this application of synthetic thinking would provide "automatic" *motivation*, *commitment* and *coordination* for free, thereby reducing the need for managerial attention to a bare minimum [and possibly advising managers to take a more valuable, whole company-involving, change-leading role].

flexibility, some clearly indicated functions for some other "user" system, with adequate reliability / stability within a pre-defined perimeter of external conditions.
. It is "closed", with outside inputs and outputs defined well enough.
. It "evolves" / reconfigures on external interventions by the designer, manufactures or user (or on its own, if so designed / enabled).

- A *"designed network"* is equally made to perform (with various levels of flexibility) some functions with adequate reliability / stability. Differently from a "system", usually:
  . It's "open" [intrinsically connected / connectible].
  . As such, it's capable of "evolving" [structurally] by aggregation of new connections, or connection with other network [on external intervention], or internal self-reconfiguration.
- An *"evolved / evolving system"*, usually:
  . "Generated itself", on its own [for "social" systems, which include intelligence and willingness inside, with some political choice, or design, by some of its parts].
  . Is fully "open" and operates accordingly ["evolution", of course; "aggregation"; "reconfiguration"; "emergences" / "morphogenesis", ...].
  . However, does not ensures reliability and stability [if not by chance, i.e. it's been "selected as such"], for two reasons: there's no "user system" to which provide its functions; most probably, there's no purpose, if not a "blind" one to exist and evolve, without any reason or meaning[11].
- A *"mixed system"*, usually is a [socio-technical] system evolved since long, composed of designed systems, networks and evolved / evolving systems, for which the above comparative scheme does not apply and really tough issues start to bear, like:
  . The fact that *complexity ever grows...*
  . The fact that *any attempt to control a complex system just makes it more complex...*
  . The issue of *whole planet, Gaia*[12]*, eco-ethics* [of which global warming is just a subset].

The "objectives" of the above categories are very different:

- A system truly has a purpose only if it was "designed". As an example, the Internet owes its expected resilience [yet to be demonstrated in a truly critical situation] in part to its structure (specifically designed and evolving in an expected way according to predefined rules), in part to its protocol (specifically designed for this purpose).
- An evolved system, instead, just "faced" what it got in touch with, and so "co-evolved" with that environment. If it had not an "implicit behaviour" oriented to survival, homeostasis, and everything else useful to avoid extinction, it would not exist any longer [therefore, somehow, it "has" those "objectives"; but actually they are just "implicit behaviours"].
- Mixed systems have "many" objectives ...readily ending-up into politics (more below).

Here, complexity-based hints are about the choice of letting systems self-heal, or self-organize.

Two examples (both in line with the above indicated paradigm shift from *devising allegedly sufficient solutions* to *ensuring the necessary conditions*):

- People who are heavily traumatized by traffic accidents usually are first "stabilized" before surgery, by keeping their vital parameters within their proper ranges. It's been discovered that, by allowing these parameters to fluctuate with less restrictions, injured patients may have more room to do their best for themselves, on their own.
- In organizations, there's no real way of eliciting learning, with the notable exception of providing the [necessary] environmental conditions for it to emerge and develop, again on its own.

A different issue works just in the opposite direction. It may become a critical, possibly urgent, and non trivial matter deciding "whether", "when" and "how" to substitute a "mixed" subsystem with a "(re)designed" one:

- The hypothesis, to be seriously considered, would be a sort of "selective reengineering / rewinding" of the evolution that brought about the present situation.
- A "(re)designed" subsystem would, possibly, be more dependable than the original "evolved" one [with its dependability possibly be more important for the whole than its capability of evolving].

The indicated hypothesis may become an opportunity, by carefully comparing the risks of:

- Performing the substitution, which would require a major intervention.
- Leaving things as they are, which would be straightforward, but possibly dangerous / even more risky.

[11] The existence and functioning of such systems are often interpreted "teleologically", and considered "successful" since they emerged – even by sheer chance – from the co-evolution with other systems, are resilient and evolve.

[12] Gaia, the whole "living" planet, is the largest, and most prominent, example of an evolved and evolving system, where even the environment is conditioned by life, in an overall life-enabling homeostatic system, where even bio-diversity has a role, i.e. the more species the better. Now, Gaia has been turned into a "mixed" system, ...and problems arise, at any level.

4.3. Society

Society is where we find most mixed systems; said pictorially [and bluntly]:

> *Complexity is all about humans to choose:*
> *whether to destroy themselves, or ...start "learning".*

Very general, really tough issues – like eco-ethics – will not be discussed here. Even discussing the whole society would be impervious. On the other hand, discussing subsystems will be unavoidably partial, but there's no other choice.

Three "viable" sample subjects – all about economy – and a hint of general validity have been chosen:

- Adam Smith's invisible hand.
- Role of infrastructures.
- Acknowledgement of unpredictability.
- Focus on mistakes.

About them, "doubtfully complex" views will be provided, given the above indicated limitations.

On the other hand, in the discussion about infrastructures [which are subsystems of the whole economy], we shall start questioning whether to substitute some of them with (re)designed versions.

Adam Smith's invisible hand

When confronting complex systems, Adam Smith's theory sounds overly simple. It reads – disrespectfully – as follows:

> *Try to make more money on your own:*
> *the system will take care of itself.*
> More bluntly: *Be greedy, and everybody will benefit.*

Surely, this is a proper solution, even the best possible one, to build a non existent economy. The subject matter is whether this rule keeps holding today, and may still be the right choice, to mend a now rotten economy[13].

Since the invisible hand brought the economy where it is now, the answer definitely seems to be negative, for a number of reasons:

- Albert Einstein's well known saying:

  "A problem can't be solved by the same mindset which contributed to create it."

- A scenario of ever increasing change, and speed of change as well. The positive effects of the invisible hand on the society of Smith's time may well be false today (by what magic should Smith's view hold unaffected?):
  . Relativity, quantum mechanics, and the like, profoundly change our view about physics. Should Smith's view about economy hold, unperturbed?
  . Economists' theories last little longer than the time between two crises. Should Smith's remain valid for over two centuries?
- If we all keep following our own individual interests, the real risk is that Smith's view may have become just wishful thinking, by now:
  . All intermediaries – e.g. finance – seem to start as supporters of the economy and to end-up as parasites...
  . We are depleting the planet, running "shaky" socio-economic systems and well in the position of possibly blasting everything [there's been little "systemic" thinking in the last economic and military crises...].

To summarize, in a complex perspective Adam Smith's rule reads as follows:

> *Let's let everything self-organize.*

A too simple rule to still hold, plagued by very deep, multiple paradoxes:

- A total, conceptual clash with the concept of economic governance...
- Within the unsolved issue about where and when, in the economy, to choose control and where to choose laissez-faire.

Role of infrastructures

The continuous "emerging of variety" within the economy, due to [free market] complexity, entails diversity in general – of debatable value, although so much praised – and large negative effects on infrastructures:

- Variety generation in free markets is meant to pass the test of competition, ...were it existent and fair. It's not. We have other "emergences", instead, like too-big-to-fail companies, (private) monopolies, oligopolies, information asymmetries, market distortions / disruptions, ...
- The problem particularly impacts infrastructures, where private ownership, naturally managed for profit, is incompatible with the best solution, i.e. – just the other way round – providing infrastructures for free, as soon as allowed by technology (and an improved organization of the economy).

In today's economic culture, infrastructures are even not well differentiated from services. Admittedly, there's a thin line between the two (and possibly even moving in time), but we might / should strive to draw it.

Good candidates to be considered "infrastructures" are subsystems of the economy – like banking, tele-

[13] That the world economy is "rotten" is, of course, a debatable statement. It will be considered true here, just for example's sake.

communication, motorways, water supply, etc. – which have the following characteristics [very similar to those of the "designed" systems in the above categorization, which provide reliable, specific functions to their "user" system]:

- Serve the rest of the economy.
- Are used by everybody.
- Had better be dependable / mission-proof.
- Ought to be professionally managed for the best service-cost ratio.
- Are provided at small cost, or can be.

The "so defined" infrastructures should not be held by private hands [and, hence, should never be privatized, when public]: from banks to insurances, to telecom operators, to highways. Governments are bailing out banks; weren't they part of the economic "infrastructure"?

The crucial point here is not what the right approach might be, but the loss of alternative options brought about by careless decisions. When these "possible infrastructures" are privatized and, consequently, managed for profit, there's no chance any longer to (re)design them according to the needs of the economy as a whole.

Said bluntly, "private, for profit" – as well as, possibly, "pricing" – are sheer anathemas for infrastructures:

- A large parte of the health service in Italy is provided for free: why should citizens pay nothing for health service, and pay for a phone call, instead? Or pay for a payment: a kind of absurdity (although banks long profited on that).
- Seeing the problem from another point of view, we have a lot of very small payments, where the overall system cost is possibly higher than the payments themselves. In a world where we could not "minutely pay" for official stamps, postage, basic banking, basic insurance, health service, and so on (you name it), people could spend their time and use their technologies for more productive endeavours than petty payments.

Two more examples of "useless pricing" are public transport and motorways:

- What's the real (i.e. systemic) value of public transport tickets, which cover just a small fraction of total costs? Aren't they, possibly, just a useless complication? If city majors really want people to stop using cars, why don't they provide public transport for free?
- Tolls on motorways are partly collected by people, partly by electronic devices. Wouldn't be better, instead of toll attendants, to locate an ambulance, a tow truck and a police car at every gate, ready to intervene for any sudden need? Why should we deploy toll collection technologies, instead of adopting Swiss-like, low-tech annual stamps, or – better – eliminating any charge whatsoever?

To the question that somebody asked – "Do we really want a more robust system, or do we want a better functioning system?" – the obvious answer was "more robust infrastructures for a better functioning system."

There's a very basic problem, however:

"The obvious is not ensured."

Giuseppe Mazzola

Acknowledgement of unpredictability

Coping with unpredictability is the dark side of complexity, the counterpart of its large explanatory power:

"How do we assess risks?"
"Sorry, we have run out of heroes..."

Infrastructure-related risks are particularly severe:

- Banks are an infrastructure for the real economy [definitely: the opposite would be silly; instead, it's in part how things work now, with finance operating as a parasite of the economy...].
- When a should-be infrastructure stubbornly works for itself, and then finance collapses on a global scale, the damage spreads heavily into the real economy.

There are at least two unsolved [severe] problems:

- Gaussian statistical distributions used in models, when actually they are "long tailed" [this can be solved, but it seems like GNP: silly measure, stubbornly kept in use];
- More severely, *the true risk is actually the unforeseen one*, which limits the use of maths in risk management, and asks for a more proper use of ...brains.

Definitely, somebody should take better care of all systemic risks. In this respect, two good starting approaches would be:

"Rather taking care of 'exposure' (the severity of the outcome) than 'probability' (the chance of the adversity)".

Nassim Nicholas Taleb (rephrased)

Not generating "superfluous" risks on top of those we face already.

Considering the above Einstein's and Mazzola's sayings, the future is cloudy...

Focus on mistakes

As a hint of general validity, we should not strive so much to "solve big problems", as to "clean big mistakes", and let the problems (originated by the mistakes) mend themselves, on their own. Two exam-

ples are:

- Understanding that controls shouldn't be exerted on scientific research, but on its economic and military applications [which should be then held accountable for all their possible damages, and legally bound to pay[14]].
- Imposing, by law, to pay the temporary jobs twice as much the long-term ones, thereby correctly rewarding the flexibility provided to the employer and the corresponding risk borne by the employee.

5. Conclusion

Epistemology is clear:

- The laws of complexity literally build-&-shape the world.
- Humans can just try to make sense of it, in endlessly running after the ever growing variety [of which most, not trivially, generated by themselves].

Disciplines are solid, clever, useful ...and helpless:

- They just (apparently) solve local problems. They never see the big picture.
- The approach to tackle the big picture is different from the local approaches. Hence...

"Understanding" is key:

- Measurement is pointless without understanding; with understanding, it tends to be superfluous...
- Measuring risk may well be pointless, as well: the real risk is "elsewhere", by definition [i.e. in the variety generation capability of (the laws of) complexity].

Flexibility is key:

- In organizations, you can have it.
- In IT, you must build it.
- In culture? ...A long shot.
- Learning is key, as well, since it's the foundation of flexibility...

At present, the author's position is as follows:

- Complexity should be treated *simply* (otherwise, we'll generate the fog made by the various disciplines, again).
- **C***omplexity is just an* **e***ndless* **v***ariety* **g***enerator, for sheer* **evg***'s sake*, from which there stems a long list of interesting properties. The most important ones are:
  . Once one has *endless variety generation*, ...one has *everything*.
  . *Learning* is an *evergreen need* to make some sense of the above.
- On the other hand, we may want to put some halt whenever the outcome of variety becomes too dangerous, or clearly damaging:
  . [Contrary to "complex" thinking,] here a sheer "design"-oriented attitude might have to be adopted, in search for the simplest solution.
  . [Between "complex" and "systemic" thinking,] alternatively a "synthetic" thinking-oriented, team-based approach – aimed at "reengineering" / "rewinding" the evolution that brought about the present situation – might be the approach of choice.

As written by a layman, all the above may well be right or wrong.
However:

- The mental models behind it are "exposed".
- The whole is coherent.
- Some possible practical consequences are preliminarily investigated.

There's ample material for rebuttal:

- Nothing is "definitely set".
- Had the literature provided some sort of "understandable truth", there wouldn't be this article [which – in the end – is little more than a provocation to disprove it].
- The hope is that refutations may have the same characteristics – *exposure of mental models*; *internal coherence*; *investigation of consequences* – ...because the [non academic] readers badly need them.

Acknowledgements

Thanks are given to Principia Cybernetica Web for the wealth of information provided by their huge website, Valerio Eletti [and friends] for his seminars about complexity, Carl Henning Reschke and Andrew Wilson for the topics discussed together.

[14] The BP's offshore platform in the Mexican gulf made large "local" damages; the guys in US banking are hitting the whole world, instead. BP paid US for the damage, and is now suing Halliburton to be repaid (lovely!); but, apparently, the whole world can't sue the guys in US banking, to be repaid (hateful!).