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TOWARDS A PRAXIS FOR COMPLEXITY:
DEVELOPING A WISDOM FOR DECISION-MAKERS?

RESUMÈ

La resolution des problèmes complexes a besoin de ***sagesse*** *plutòt que de* ***rationalité.*** *L'intention de cette intervention est de montrer qu'on peut développer une recette de sagesse pour les décideurs.*
A l'aide des aspects d'auto-similarité de la complexité, les problernes semblent faire partie d'une même classe à laquelle s'applique le même paradigme de solution (l'approche ‘design’).
Le processus de solution doit d'abord passer par la phase de "spécification" du problème de définition du 'client'. Le paradigme "design" s'applique aussi à cette phase.
Les cas de défi de la globalisation montrent que divers acteurs peuvent réagir au même défi en le transformant en différentes spécifications du problème. La sélection du meilleur acteur pour y répondre, fait partie du problème.
Les defis peuvent sortir d'un niveau spécifique de la hiérarchie du système. Malgré cela, le système entier - à travers ses interconnections et des jeux réciproques de cooperation-competition - est impliqué par le défi. Le décideur doit tirer bénéfice de la réaction intrinsèque du système au défi, en cherchent des effets de levier.
La ***recette de sagesse*** *comprend l'application du paradigme du "design" à toutes les phases de solution du problème et la recherche des moyens pour assurer que le couple 'cooperation-competition' se développe à tous les niveaux dans la hierachie du système.*

SUMMARY

Problem-solving for complex issues requires ***wisdom*** more than ***rationality.*** The intent of the paper is to show that a *wisdom recipe* can be develop for decision makers.
With the help of self-similarity aspects of complexity, problems appear to belong to a unique class to which applies the same solving paradigm (the *design* approach).
The solving process will first of all have to pass through the phase of "specifying" the problem and defining the 'client'. The *design* paradigm applies also to this phase.
The case of globalisation challenges shows that many different actors might feel the same challenge, then transforming it into different problem specifications. Selection of the best actor to respond to the challenge is part of the problem.
The challenges might emerge from a specific level of the system hierarchy. Nevertheless, the entire system - through its interconnections and through an interplay of cooperation-competition - is involved by the challenge. Decision making should take advantage of intrinsic system reaction to the challenge, looking for leverage effect.
The ***wisdom recipe*** include the application of the *design* paradigm at all the phase of problem solving and the looking for ways to assure that the couple 'cooperation/competition' develops at all the levels in the system hierarchy.

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TOWARDS A PRAXIS FOR COMPLEXITY: DEVELOPING A WISDOM FOR DECISION-MAKERS?

1 Introduction

Whatever the definition of complexity we should distinguish between the attitude of those that try to understand a complex system from those that have to act to modify it. The major preoccupation of the observer of a system is to avoid to perturb the system with the observation activity, while the reverse is the purpose of who has to decide what to do to change the system to move it to a specified goal.

Nevertheless, the cognitive approach has been strongly influenced by the practical one. On one hand, the push to search for a "compressed algorithm" (model) that can describe the system behaviour means to be able to use the algorithm not only to reconstruct actually observed behaviours but also to forecast the future ones. On the other hand, the decision-maker cannot act on the system unless he *thinks* he can predict the behaviour of the changed system. For him the availability of a model to describe system behaviour will certainly be very useful. Actually, one could advance a definition of a decision-maker as someone who has a kind of "compressed algorithm" to guide his actions to modify the system.

What happen, however, of this concurrent interest when the cognitive investigators have to recognise the irreducible aspects of parts-globality interactions in the system? The cognitive motivation of the historian and philosopher can be satisfied by the recognition of an unbreakable holism, of the impossibility to generalise the singularity of the events. But this recognition will be of no help to the decision-makers which will need nevertheless some practical guidance to the decision. This might explain a closer alliance between the decision-makers and the reductionist scientists (separation of the "*two cultures*").

Such alliance enter into crisis when the scientist himself has to recognise that there are conditions where the reductionist approach is not valid. There are islands of stability in "physical systems" where a model can be developed.

[1]Centro Studi Sistemi - CSS - Centre for System Studies
via Vela 27, 10128 Torino (Italy) tel. + 39-11- 562.30.88 / fax. +39-11-436.06.79

However, there are transition zones from one to the other islands for which the compressed description provided by the model is no more possible. The recognition of the impossibility to predict the future state of the system when passing through a transition zone might satisfy the cognitive motivation also of the physical scientist, and can lay a bridge between the "*two cultures*" toward a "*nouvelle alliance*".

Our basic concern here is to understand if such alliance on the cognitive front will be of any help to the ***praxis goal*** to intervene on a system to force it to follow a certain trajectory.

In fact, the reductionist approach is the only one available to act on a system. One need to breakdown it into parts small enough to be possible to intervene on them. One cannot act "directly" on the globality of the system to modify it! No matter how complex is the object on which we act it will always be "part" (sub-system) of a larger global system. In case the system is within an island of stability, the "compressed" description will be of help to the decision maker to predict the future state of the global system after having modified one or more of its parts, essentially because the system will see the modification as a "small perturbation" that does not change its basic structure (it has "*slacks*" available to accommodate the changes). When however the decision-maker act on a system which is in a transition mood, no perturbation can be considered small enough not to influence the system globality. Will it be possible to predict the influence of the perturbation on its future trajectory?

Paradoxically, the situation is, in such condition, more favourable to the practical approach than to the cognitive one. In fact, the basic difficulty for the cognitor is actually the high sensitivity of the system so it might be impossible not to perturb it while observing. The practitioner instead aims at modifying the system, so he can take advantage of the system sensitivity to "move" it with very small actions. And because of the intervention, the system will "choose" between different potential alternative trajectories.

The problem for the decision-makers is whether or not he has tools to forecast the system behaviour, to see the alternative trajectories and to recognise if the system is on a "*saddle point*". In this latter condition he could hope that a small intervention might be enough to "*break the symmetry*" between the alternative routes.

Of course, the decision-maker might feel the transition, but not be (himself and the "subsystem" on which he can directly act) on the "verge of the saddle". This might explain why there are successes and failures in the attempts of different actors to react to the same challenge.

Could here the "*nouvelle alliance*" between humanists and scientists help the decision-maker? Is there a "***wisdom***" (knowledge and virtue) ***of complexity*** available to guide the activity aimed at changing the system (problem solving)?

The word "wisdom" is used here as a counterpart to rationality. The "rational" behaviour of decision-maker underline optimisation (minimum use of resources to produce the sought effect) which might be possible only when a model (compressed description) of the system is available. A "wise" approach should assure that at least qualitatively (good enough solution) the objective is met (the change is in the desired direction), even when not in such condition.

The situation that ask for a "wise" approach is quite common. However we tend not to recognise the difference with the cases where optimisation is possible thanks to the availability of practical recipes for actions (that condense the wisdom coming from past knowledge on decision-making for problem solving).

The question utters to our attention all the times we think we are confronted with a completely new situation, when we feel a transition to an unknown territory. A recent important challenge to decision-makers comes from the feeling that a "globalization process" is underway which is transforming our social, economic and technical systems. We will use the case of the "globalization challenge" that face the decision-makers to develop a positive response to the above question: *whether or not we can develop a praxis to deal successfully with complexity.*

2 Self-similarity of complexity

The first task of a decision-maker facing a problem to solve is to identify it (problem definition) and then try to classify it hoping it will belongs to a class of problems that he is familiar with.

In the case of ***globalization*** issues, the difficulty to translate perceived challenges in terms of problem specification tends to lead to the conclusion that we are faced with a new class of problems that we are not instrumented to approach.

If we describe a complex system as an organised hierarchy of interacting components, integrated in sub-systems, we might classify the level of complexity in terms of the number of hierarchical levels in the system organisation. Since "*globalization*" is characterised not only by an increasing degree of interactions between existing "*local*" components and subsystems, but also by the appearance of new subsystems having a world wide dimension, we can classify it as an higher level complexity compared to current socio-economic-technological systems.

If we assume an input-out approach to problem-solving (the problem is the input, the solution is the output) then the problem-solving process can be seen as an algorithm that can process (solve) only a certain class of inputted problems. The first preoccupation of the problem-solver will in such a case be to see if he can *compress* the problem description to apply a known solving algorithm. If this is the only approach to the globalization problems, then our chances to deal with them will be very scarce.

The input-output model assume that the problem is well specified with no ambiguity and well spelled out terms of reference. In practice this is very seldom the case. As a matter of fact, a characteristic of complexity, seen from the decision-maker point of view, is the fuzziness in the definition of the problem to be solved, the ambiguity not only in the input but also in the output to be desired. What is the impact of this situation on the classification of complexity problems?

We are used to complexity of different levels. We face it everyday. However, in reacting to complex issues classified at different levels of complexity do we use different problem solving procedures according to the level of complexity?

To try to answer we need, firstly, a closer examination of the meaning of the number of hierarchical levels in a system. To count them we should expect, starting from the upper level, to find a net separation between the system and what is outside (the environment). Going down the hierarchy we find subsystems made of components. The components, at a closer look, might appear actually as subsystems made of subsystems. We stop the subdivision when we reach a level where the components are no more sub-divisible ("atomic" components). The system will therefore be delimited by an "external" environment and an "internal" one (represented by the inside of the "unbreakable" components).

In complex social systems there is a large ambiguity on both the upper and lower levels of the system. Here is where the interaction between the decision-maker and the system start to work. Implicitly or explicitly, the decision maker has first of all to decide where to place the division between the inside of the system and its environment, and what are the components that practically have to be considered as unbreakable bricks.

More than by an *input-output* model the situation is better represented by a *constructive* model. At the beginning of the problem-solving process we might consider two separate system: the problem-solver and the system to be changed. The problem-solver perceive a problem and start interacting with the system that produce such a problem. The interaction starts a process of construction of a new system that *self-organise* searching for a "*closure*" that assure that the inside of the system is made of the problem-solver with its solving tools and of that part of the system to be changed that is compatible with the solving capability of the decision-maker.

The case of reacting to the needs to improve the transportation system might illustrate the point.

If an automobile manufacturer is the one who takes the challenge, he will consider the automobile as the system he should deal with. The transportation system for him becomes part of the complex environment. *His* system remains a very complex one and the innovation changes difficult. He knows that the components in the automobile are complex systems. However, he has to as-

sume that they are given and unchangeable.
If the challenge instead is taken by a public authority responsible for urban development, the automobile will become one of the atomistic components together with other transport vehicles while "his" system will include not only transport infrastructure but even urban planning.
On the other extreme, for the automobile components manufacturer the automobile will be considered as the given external environment.

From the point of view of decision-makers we can say that complex system appears as "***self-similar***" objects: with a magnifying lens the atomic bricks look as complex systems, having as environment the higher level subsystems. From a faraway viewpoint, some of the former environment become part of the system. It is the decision-maker that, to act on the system, decide what is the "ruler" he will use, in this way "precipitating" the potentially infinite number of hierarchy levels to a finite one. He decides what is endogenous to the system (can be subject by the action of change) and what is exogenous (has to be taken as given).

The recognition of such self-similarity of complex social systems is a first important conclusion towards the building of a "wisdom of complexity". No matter what is the actual level of complexity the decision-maker will reduce it to a level that he can approach.

Summarising this first point, we can say that we are used to act (react or pro-act) to respond to the system challenges. The trick we use is to limit the range of the complexity to our span of reach: we "expel" higher levels making them part of exogenous environment and consider as "atomic" parts lower levels. Therefore, from this point of view, globalization problems do not appear as different from any other cases of problem-solving under complexity.

3 The "design" process: a paradigm for decision-making / problem- solving

The recognition that, seen from the point of view of praxis, complexity problems belong to the same "class" is useful provided it is confirmed by the existence of a corresponding unitarian approach to problem solving. We suggest that such an approach is provided by the design process which can be considered to respond to the "constructivist" description of the interaction between the decision-maker and the system.

To support this statement we will firstly describe the *reductionist approach* to problem solving that correspond to the reductionist approach in cognition. This approach implies an intrinsic linear chain of cause-effect relationship between inputs and outputs and that potential feedback’s could be "frozen". The problem-solving passes through a linear chain of phases: from problem-definition, to search of a solution, to implement it by specific construction actions. The boundary between the different phases are clear cut and

the responsibility of each one assigned to a specific actor (respectively, the client, the designer, the constructor).
The approach is reductionist not only in the sense that the system is broken into components on which the action will be applied, but also that the process organisation is well split into "elementary" responsibility assigned to specific actors (work-breakdown structure).
The approach is applicable even in complex system when there is a stable structure and "slacks" are available in the elements of the structure to accommodate changes. In such a case, the scope of the intervention is to operate within the slacks.

When, however, the interdependence among system members challenges the identity itself of each member, this approach to problem-solving is no more applicable in the same way as it is no more satisfactory for the cognitive approach to assume the separation (de-coupling) of variables.

In the *design process* complexity (and feedback's) enters in a not eliminable way.

To illustrate the point take the simple case of a new house. The process start with the client vague idea that he want a new home. Specific terms of reference have to be developed. To obtain them the client has to interact with the architect. This is done by a complex process that passes through considering potential solutions (a kind of "*design of the design*" or "*meta-design*") that ends when the client initial vague desires are well explained. Then, the problem passes to the architect. However it cannot right away be broken down into small pieces. To develop the real solution, a creative phase has to intervene: the specification is challenged items by items, in a "divergent" process up to the point when a "final" solution emerges.
One or more designing steps follow to detail the solution: "divergent" stages of thinking might be necessary before "converging" to satisfactory (good enough) solutions at subsystem or component level.
The process is an iterative one also when we pass to implementing the detailed design: no matter how detailed the blue prints, changes might be needed requiring interactions between the constructor, the architect and the client himself.

This simple illustration of the design process shows a "micro-world" complexity which contains all the features of complexity and non-linearity of a "macro-world".
With respect to the "linear reductionist" approach the design process follows the same schematic subdivision in three main phases and requires as well to define the actors responsible for each phase. However, as shown by the case of designing a new home, it accepts vagueness in problem specification. Inputs are not considered totally exogenous to the problem-solving process but are part of it. In building a solution, the process constructs also the specification of the problem to be solved.

The method used is that to apply at a "meta level" the process to the first phase of it. In fact, the phase of specifying the problem cannot be completed unless some idea is available of potential solution and of its feasibility. Before completing the phase one enters into a recursive chain of exploration of the next phases. The same recursive approach is applied also to the other two phases: a final solution cannot be designed unless a verification of the possibility of implementation is done and the client has given his assent that the solution respond to his wishes. The reality of construction requires revision of formerly taken decisions both at the level of the client and of the designer.
The creativity intrinsic in the design approach requires an interactive chain of "holistic" cognitive approaches and "reductionist" building of solutions. The process is a chain of circles centred around each actor. Each circle is covered a certain number of times before passing the responsibility to the next actor.

The design method requires, as the reductionist one, that each phase be the responsibility of a given actor. However, when facing complex issues not only the specifications of the problem are far form clear, but often also who really is the client that want to find a solution, who can be the "designer" and the "constructor". The design process requires that this ambiguity be cleared: at least a client is needed to start the process.

Take the case of mass products, when the "client" is represented by the market. We know that the design method can be applied. But to make this possible, the producer has to simulate himself the role of the client. For the case of a radically new product, changes in the firm organisation are often needed before the proper actors emerge. The vagueness in terms of problem specifications, type of solutions and actors definitions will become an intrinsic part of the problem for which a solution is searched.

The "design process" can therefore be considered corresponding, on the praxis side, to the "*constructionist*" approach on the cognitive side.

In conclusion, the second suggestion from the "wisdom of complexity" is that "*the metaphor of a system that try to maintain or adapt its identity by using a recursive approach to reduce the exogenous impact*", can be applied to the praxis problem under complexity, and that the design method can actually represent the process to govern such a change.

4 The globalization challenges

Let us now try to apply the design approach to the globalization issues. Global issues are far from clear, the client is not 'defined' (or the role played by an 'improper' client). We might feel the globalization challenges, but unless we succeed in transforming them into problem specifications it will be difficult to allocate the needed resources, to call in the S&T community for help. Someone has therefore to materialise the role of the client. To pass from challenge perception to problem definition, institutional development might be required and become therefore an intrinsic part of problem solving.

Globality issues are similar to the case of radically new products. The specification of the problem will depend from the ’client’ values, which will become real values (action inducing) if the client together with the designer can perceive possible solutions.

The case of global issues show not only that, when the client is defined, to pass from perception to problem specifications requires a "meta-design" process, but also the difficulty to translate challenges into specific actor perception.

A few case examples will show the ambiguity of challenge perception, actors roles definition and problem specifications.

The deforestation issue. The challenge is perceived, but there is no consensus on solutions (stop deforestation, start reforest ation, develop ’artificial forest’). Existing portfolio of potential solutions is limited and underline how vague are the issues we want to deal with (climate change or loss of biological diversity, or both?) and the priority values (long term survival or short term improvement of poverty). The looking for ideas might have to be shifted in new directions. For instance, the real issues for S&T to contribute new ideas might be that of finding uses for the forest natural ’waste materials’ or increasing production of renewable useful materials. The direction of solution searching depends from who will pay for, who is the client. The problem-solving process will not start, however, unless some one start playing the role of the client calling for the production of idea to fill the portfolio. At the end, a panoply of issues with related potentiality of responses should emerge. As a results different clients might find specific roles to play.

Desertification. Should the objectives be to stop further desertification, or also to reduce existing desert area? Shouldn’t instead mankind take advantage of the existing desert area to develop cheap solar energy? The selection of objectives will clearly depend from who the client is. To keep open this question might at the end assure a better solution independent from the beginning point of view. For example, the analysis of potential ideas to use the desert area for energy generation might point to effects of ’virtuous economic circle’ of wealth generation with short term effects also on local population. The shifting in challenge perception might change a negative global issue into the exploitation of a resource.

Marginal agriculture. In agriculture great unbalances have developed: abandoning of marginal land; increasing environmental damage; reduction of the variety of species; custom barriers. What are here the real issues? What tasks for S&T? To develop technology that make profitable agricultural activity on marginal lands? Or one should look for an occupation of the territory for other economic activities with surplus income destined to a good housekeeping of the territory? Can we separate the issues of rich countries and LDCs? Also here issues definition depends from values definition and perception of potential solution, from a balanced mixture of competition and co-operation between different society sectors.

In conclusion, the globalization issues underline the importance and the difficult to clearly define what the challenge is and the ambiguity in challenge perception. The design paradigm might be applied but it should start at a ’meta’-level (*designing the design*) in order at the end to be able to start the real design process having established actors and roles and an agenda of issues.

5 Dynamic of system responses to challenges: punctuated equilibrium

Up to now we have assumed that there is a well defined decision- maker which react to the challenge considering it transformable in terms of a "problem to be solved". The design approach requires that the determination to act be played by a "client". From the self-similarity of complexity we have learnt that he should not be afraid of the novelty of the complexity of the situation to face: he will cut-out from the broader system of which he is part, an "internal system" on which he can act. The design paradigm provides a process to produce such a "closure" (the system is delimited by the reach of the client capability to act).

The globality cases show, however, an ambiguity on who should play the role of the client which derives from the ambiguity on the perception of the challenge. Success or failures of action taking will depend very much on who plays that role. In fact, different actors might have perceived the same challenge and decide to act. The result of the design process might lead to different "internal" systems directly object of the change and the results have different degree of success (meeting the client expectation) or fail.

Each action "programme" is directly aimed at a given system, which however is part of a broader system. The action taking will therefore induce effects on the broader system and from its point of view even the failure of an initiative might not necessary be useless.

In the praxis of complexity we are therefore faced not only with the difficulty to solve the problems once they are defined, but before that to select the more efficient way to transform a challenge into a problem to be solved.

Can the "*wisdom of complexity*" here also be of help?

Let us go back to the "perception of the challenge" which is the starting point of our process. The potential decision-maker is someone who perceive it as a threat or as an opportunity. The first idea might be to consider the challenge as exogenous to "our" system. In reality this could only partially be true. Our system is continuously interacting with the environment and the "atomistic" characteristic of its elementary components is also continuously threatened by their internal complexity. Actually, we perceive a challenge because "our" system has already started to react to the change of interacting fluxes with the "external" and "internal" environment.

Is there some *typical pattern of dynamic behaviour* of complex system facing challenges from which we can learn so contributing to the building of a "*wisdom of complexity*"?

To proceed further we need to make some assumption on the system of interest. In fact, up to now the only assumption we have made is that of self-similarity of complexity (a system, made of systems, made of systems).

We will now make another important assumption which, however, should not limit too much the generality.

We assume that the system has a certain structure which impose constrains, but within them a certain flexibility is left to adapt to changing environment. We could describe the "*system flexibility*" as a certain global "*slack*" of the system. The global slack is made up of slacks of the various subsystem and components.

When a specific subsystem will be close to have "eaten up" all the slack available it will less and less be able to efficiently adapt to the push to change. In such condition there are two alternative reaction.

The first is to "transfer" the burden to react to other subsystems (at the same or higher level in system hierarchy). In this condition a "signal" of difficulty will emerge and propagate to the entire system. The response of the system might be such that the subsystem in difficulty will regain some slack, or not.

The other alternative is that the challenged subsystem (close to saturation condition) take on itself the burden and make some radical changes in its internal structure (innovation at its subsystems and components levels) so gaining new "slack".

The global ability of the system to adapt to changes will depend from the specific "trajectory" followed. One extreme trajectory will be to "lock" one after the other the ability to adapt of the subsystems. Another will be to try always to redistribute to all the subsystems the remaining global slack. Which one will be followed depends on who will react to the challenge. However in one case or the other at a certain moment the need to gain new "slack" by some radical changes will come.

The conclusion from this bit of "*complexity wisdom*" is that at a certain moment in the system dynamic there will always be a level of the system that will have to face the challenge with a radical change.

This pattern of system dynamic is well recognised in biological evolution and is named as "***punctuated equilibrium***". From an high level (in term of system hierarchy) of observation the system will appear as stable (no noticeable change in its structure) up to a moment when in a "visible" level of the structure a "radical" change will emerge (such as in biology the appearance of a new species). This pattern of dynamic behaviour observed in biological systems has been used as a metaphor also in economic and in sociological systems.

6 Developing a strategy to respond to system challenges

Let us now go back to our praxis problematique. Suppose that the decision-maker is "inside" the subsystem that is reaching the saturation point in adapting to change. He will perceive the challenge before or stronger than others not inside the same subsystem. However his decision to react by designing a solution has a high risk of failure or of low efficiency.

To better illustrate the point let us take the case of urban air pollution. Public authority have reacted by imposing in a succession of moves stricter and stricter regulations on vehicle gas exhausts. The vehicle manufacturers easily adapted to the requirements, when the problem first emerged, by a better control of the combustion. Subsequently, more expensive "add on" technology (catalytic converter) had to be adopted which still does not require a change of the propulsion system. It is still now possible to obtain some further reduction without changing the vehicle technology by some optimisation of combustion, weight reduction, better control of gear shifts. However the efficiency of this interventions is increasingly reduced and the improvement are anyway close to saturation. What the next possible answer to the challenge? In certain large cities, under unfavourable weather conditions, emergency actions had already to be taken, such as the temporary ban of vehicle circulation. Can we recuperate some "slacks", some possibility to adapt at the level of the vehicles subsystem? This will require a radical change on the propulsion apparatus, such as electric propulsion.

The fate of urban transport will certainly be quite different whether or not such radical changes can be introduced regaining flexibility of vehicles to adapt to even more restrictive future regulations. However, in the latter case the regained slacks with respect to air pollution might induce in future a different challenge: the increases in private vehicle traffic might at the end induce a traffic jam situation.

When this will happen the transport system will be forced to make a radical change at an higher level: shifting traffic from private to public transport.

We are left with the impression that the initial decision to respond at the lower possible subsystem level might force the system into a trajectory which at the end will require an higher level radical intervention. Couldn't a *better strategy of response* be developed anticipating higher level responses?

We started with the problem of a decision-maker facing a challenge that he consider as its own. The wisdom of complexity tell us that the challenge is always a challenge to the "global" system and sooner or later the system will react. The decision-making problem is always accompanied by a "*meta-problem*", that of deciding the better strategy of response including the definition of the more appropriate "client" to represent the need to respond. he decision maker might recognise this meta-problem or ignore it. The suggestion from the "wisdom of complexity" is that he better takes it into consideration.

Faced with the "meta-problem" of deciding which is the best way to define the problem to be tackled to respond to a complex system challenge, first of all one should better "listen" to the system when a challenge emerges. The signal might emerge from a specific subsystem or be more diffused. However even in the former case, the system interdependence will sooner or later propagate the difficulty to other parts. If we assume the self-similar characteristic of complex system (a system made of subsystems, made of subsystems and so on, both way down and up the system hierarchy), then we might expect an attenuation of the "intensity" of the challenge that emerge at a given subsystem level as we go up in the system hierarchy. In fact a radical change of the system structure at a given level (that might "destroy" current subsystems and create new ones) not necessarily will threaten the system identity above a certain level. In the same way, lower level components might keep there identity even in a completely new arranged subsystem structure.

To respond to "local" difficulty with a local action not necessarily is the best approach. But can we delimit the levels of the system to be involved in responding to the challenge?

We might propose the same trick that we have recognised to work for the approach to a "real" problem solving: delimit the number of hierarchy levels by cutting out of the system (whose identity is threatened by the challenge) the upper and lower levels where the threats is below a certain threshold. Within this delimited system (made of a finite number of hierarchy levels) we can assume that the challenge is perceived at all the system level with an intensity enough to provoke concern and willingness to transform the challenge perception into terms of reference for problem to be solved.

Several actors can therefore play the client role. The problem is that to choose the more appropriate ones to assure to maintain system identity and recuperate further slack for future needs to adapt to upper and lower level environment changes.

One can envisage two general type of response. First of all, try to understand if by "shaking the system" - and therefore redistributing the "load" between the different subsystems - one could solve the problem without changing the current structure. We might call this a "*tactical response*" to the challenge. The second is to take advantage of saturation in some subsystems to anticipate structural changes at that level to get much more slacks available for future adaptation of the entire system. We might call this a "*strategic response*". In one case or the other one has called in a certain "co-operation" of system elements to develop a response to the challenge.

The design process applied at a "meta" level can help the meta-problem solving approach by producing as outcome the definition of the "clients" for the actual problem solving. At this meta-level the design process will follow its proper scheme: problem definition, solution design, implementation. The clients to start the problem definition phase will be tentative clients "co-operating" among themselves, the solutions will be conceptual, the implementation will be kept at the abstract level of model.

In the case of globalization, the difficulty to treat issues comes from the fact that the entire system structure is close to saturation. There is therefore a threat to the identity itself of the higher levels of the current system structure. The "wisdom of complexity" tells us that, even for this case, the situation is not really a novel one.

7 The case of planning technological innovation changes

A recipe for complexity praxis emerges from the above considerations: do not assume as given that the level of intervention to respond to the challenge. To induce a global response to the challenge in general will help to be better off for the future.

This recipe find a clear application when the object of the decision-making is the plan for developing technological innovation changes.

In planning innovation changes for complex systems, a hierarchy of innovation objectives has to be posed: objectives can consider only components innovation (*tactical innovation policy*), or consider subsystem innovation (*strategic policy*), or even the entire system change (*structural policy*).

The case of transport issue will again be used to clarify the idea. The challenges includes energy conservation, environment protection, avoiding saturation of transport infrastructure and improving quality of life in urban environment. Contribution to the challenges can be obtained aiming at innovating the today public or private vehicles (the ’components’ of the transport system). There are however limits in the result that can be obtained with such constraints in innovation objectives. One can think to innovate at ’subsystem level’, e.g. developing new and more efficient public transport that will produce a shift in demand from private to public transport. ’Components’ (building blocks) for such innovation plan might not, however, be there. So, efforts should be dedicated to prove that new solutions can be developed for public transport (e.g. public modes of transport that can have a flexible, demand responsive, routing). Finally, the results might not be satisfactory, unless one innovate the entire system, which might require to include, in our planning, the change of the ’environment’ of the transport system (e.g. urban planning to reduce saturation effects of congested transport demand).

The case of innovation plan shows the importance to consider a "hierarchical" response to a system challenges if one assume that the challenge is continuos in time. If we feel it as discontinuous it is because the system flexibility to adapt to environmental changes makes the threat or the opportunity apparent only when above a certain threshold (punctuated equilibrium). An hierarchical response permit to anticipate system adaptation to future needs.

The introduction of the time aspects could be done at the level of components, of subsystems or of the entire system. So, in principle an innovation plan can introduce short, medium or longer term actions at the level of the components. However, the longer the time span the higher the uncertainties including those related to changes in the higher level of the system hierarchy, if for no other reason because of the diffusion of the effects of the changed components. So, for an efficient innovation plan, the longer the time span the higher the level of system hierarchy included in the plan. Of course, the higher the levels of innovation change and the longer the time for solution, the higher the uncertainties.

Applying these considerations to globalization issues, it is first of all important to show that also for global challenges, not all conceivable actions are long term, difficult to realise, requiring radical organisational and institutional changes. A classification of globality issues shows that indeed they can be classified according to their 'range' (as local, regional, or global), and that, even when having a real global range, results can be obtained acting on components, or sub-systems. In case of complex social issues, like those of globalization, it will be difficult to have the needed society consensus on innovation actions if we can point only to long term uncertain successes. So, an acceptable plan should include a high proportion of short term tangible results, to make acceptable the devoting of resources to more radical and longer term actions.

In conclusion, a balanced innovation plan for complex issues should make the following assumptions:

- first: the today 'system' has 'slacks' available to adapt to the globalization challenges. Priority should be given to use such slacks (component innovation changes);
- second: there are issues that require innovation changes aimed at sub-systems (strategic innovation policy);
- third: the long term challenges require basic (structural) changes in values and behaviour (system innovation).

8 A unitarian scheme to respond to system challenges

We have started by posing the question of whether globality issues belong to different classes with respect to other complex problems we are used to. With the help of the self-similarity of complexity (seen from the problem-solver point of view) we have arrived at considering the problems as belonging to a unique class to which the same problem-solving paradigm (the design approach) can be applied.

However, the application of the design paradigm have helped us to see that

problems are very seldom clearly stated and that the solving process will first of all have to pass through the phase of "specifying" the problem. The design paradigm can be applied also to this phase, but at a more abstract (or meta) level to define what really is the problem that a specific "client" want to solve.
The case of globalization challenges have shown that many different actors might feel the same challenge and transform it into different problem specifications.

Not necessarily the decision of a specific client to act will produce a successful result (for the client and for the system in general of which he is part). We have been forced therefore to enter into a more general problematique.
The challenges might emerge from a specific level of the system hierarchy. Nevertheless, the entire system - through its interconnections - is involved by the challenge. Should, anyway, one react to a "local" challenge with a local response?
The case of planning technological innovation changes has shown the importance that a "strategic mix" of initiatives be performed in parallel to assure not only short term response but longer term ones. Since actions require destination of resources, a co-operation is needed between different system elements to overcome "egoistic" interest (competition) in using the limited available resources. In the case of a firm's innovation plan, "scarce" financial and human resources will have to be distributed to the different level of the innovation actions.

In the case of innovation we have introduced a "time" dimension to classify different type of actions. However the time dimension is strictly interconnected with the level of system hierarchy: the longer the time span, the higher the level of system potentially interested in the innovation change. In the general case, the innovation example shows the need to develop a response strategy that involve not only the local directed interested level but also higher ones.

The case of the globalization issues show how difficult it might be to sort out the interested level of the structure due to the ambiguity of the challenge's signals. We might therefore be led to change and generalise our initial question: *are the challenges emerging from complex system classifiable into different level for which different response approaches have to be developed*?

Here again we can use the self-similarity of complexity (this time as seen from a more abstract level) to bring back the problematique to a unitarian form. And the design paradigm can also be applied here at an abstract meta level.

The next reflection is that *different problematiques are actually different aspects of the same one,* as seen from different levels of the system hierarchy: we are dealing with a unique self-similarity issue, that of responding to system challenges.

To see this unity let us consider a system with a simplified 3-levels structure: the level of components, that of subsystems and that of the "global" system. The challenges emerge because the system react to environmental changes to keep its identity. The challenge might emerge at a specific component level. The reaction of such a component (which is on its own a complex system) does not necessarily threat the system integrity even if the components will pass through radical changes, provided the subsystem structure to which the component belong will not be affected. From the global system point of view we can see such a case as a well defined problem with a well defined client. The design method can be applied in its first "input-output" instance.

If, however, the subsystem level is interested by the change, the challenge will be perceived by the global system point of view as more ambiguous, less clearly defined and of more direct interest. Even in this case the client might be defined (a specific subsystem). However the actual specification of the problem is more vague and a "constructivist" approach might be necessary to better define which part of the subsystem should be interested by the changes.

Since the same components might be part of different subsystems, other "clients" might emerge perceiving the challenge of direct interest.

If we make a step further and consider the challenge to touch directly the global system, now even finding where the challenge is localised is much more difficult. New subsystems might have to be developed and not only to adapt the existing ones. This is exactly the case of many of the globalization issues. In such an instance many potential alternatives for actions might have to be analysed followed by a learning-by-doing.

We can envisage that through a kind of "trial-and-error process" at the end the needed change will be identified. This process, which is well known to the cognitive search, might be, however, quite difficult to be pursued "in vivo" on complex system and have destructive effects. Take the simple case of facing the problem of a traffic saturated urban environment. We feel the challenge, we start some actions on the field. However even some quite simple decisions (as the one to change the direction of one-ways or to close a small part of the town to private traffic) might produce a lot of turmoil and resistance from the inhabitants. It might be difficult in such condition to sell the idea that we are experimenting to learn from the system! This might explain the difficulty to respond to challenges coming from complex social system.

The three different cases pertain actually to the same type of problematique. The global system could decide to act at the global level even in the first of the described cases.

What we here suggest is not only that the picture is unitarian, but that a fundamental self-similarity apply: the problem of the first category can become one of the third category if we move down to the level of the interested component and consider it as our "global system". Vice versa, a challenge that touch the globality of the system might be brought back to the components level by broadening the system under attention (including higher hierarchical levels). In all the case the design paradigm apply.

The case of innovation planning to respond to system challenges allow us to add a further aspect of the fundamental unitarian scheme for the praxis of complexity:

- there is a ***synchronic*** *self-similarity*, meaning that the same challenges can lead to responsive actions with approaches that are apparently different (to solve a well defined input-output problem, or to construct a problem specification, or to meta-design the couple challenge/client) according to the level from which we look at the problem;
- there is a ***diachronic*** integration of the different type of actions at the different level, the lower level response being aimed at shorter-time terms than higher level ones. Moreover, while short term changes at components levels might later induce changes at subsystems level, the longer terms actions to change system structure might accelerate changes at lower level preparing the ground for such a changes to be possible.

9 Putting internal system forces to work

Up to now we have made - to contribute to the building of a wisdom of complexity - quite general assumptions: the one on the self-similarity of the system structure and that of the punctuated equilibrium dynamic. Both assumptions have led to indicate a base trick to use: that of delimiting (into a few levels of hierarchical structure) the system to consider affected by the challenge.

Internal to the delimited system we can divide the general decision-making problem into two phases: the first, to ask for a "co-operation" between different system elements to solve a "meta-problem" of deciding the distribution of resources and initiatives to different actors, and a "competition" phase with each actor looking at his specific problem to be solved.

We have indicated a process tool applicable to both phases: the design approach. The design approach however does not assure necessarily the success of the different initiatives or efficient uses of system resources.

Can we make a step further in looking for a "wisdom" of complexity to tackle the problem of *assuring high probability of successes to the planned initiatives?*

As we know from more conventional application of the design approach to the design of products, there are good design and bad ones. Can we detect some characteristics of a design approach that assure it to be a "good" design?

In general, a difficulty that a decision-maker has to face is the smallness of the available resource to move the system large inertia. This difficult is quite clear when one has to face globalization challenges.

Taking into consideration that the system already react to changes itself, the problem of a clever decision-maker is to try to "guide" the system to move

using its internal forces to look for a leverage effect.
We have already mentioned the case of the system being on a saddle point, on the verge of a bifurcation between two different trajectory. A small intervention in that condition, to break the symmetry between the two alternatives, will have a great effects.

In general to obtain a leverage effect it will help very much to understand what are the "elementary forces" that act on a system that assure integration between interacting elements and the structuring into an hierarchy of levels of subsystem.

We will make here a further basic hypothesis on the characteristics of the system of interest: that such a force is a field of "*co-operation and competition*".

This hypothesis, as the one on punctuated equilibrium, is suggested from the *biological evolution metaphor*. As well known, the metaphor points out as basic system features that explain the system dynamic, those of "generation of changes" and "selections of the fittest". To this, however, one should add that the "elements" that belong to the system do "compete" between themselves to pass the selection, but implicitly or explicitly they also "co-operate" (co-evolution) to be better off in passing the selection mechanism (some time also succeeding in modifying the environment). These features are self-similar: we found them at all the levels of the biological scale (from genes, to cells, to individual, to species).

We assume here that *the pattern of dynamic evolution through punctuated equilibrium can be a consequences of the competition/co-operation process*. In period of stability, when the system has ample slacks available to adapt to environmental changes, the system elements competes among themselves. In so doing an unbalances develop that the system can accept up to a point. When it has cumulated a large enough unbalance a radical change will develop at the level of the interested subsystem. To perform the change the subsystem elements will have to interact in a sort of co-operative way to build a new subsystem structure.
Indeed, by observing the unbalances in human systems we note that they increase when competition (or self-interest) is pushed to the extreme without at the same time developing some kind of co-operation.

One possible reaction to reduce unbalance or to stop its growth, is to develop "barriers" against competition (to try to respond using the less and less efficient capability of adaptation of a system close to saturation). This response will have only transient effects, and, at the end, increase the unbalances to be followed by great oscillations to readjust the unbalances to a more reasonable level. In fact, to set up barriers is in contrast to the intrinsic system trend to increase interdependence and interaction. "*General wisdom*" suggests that the ones who contrast "global" system trends are condemned to be "losers" ("great men have always 'understood' and been 'interpreters' of their time")

A better solution is instead that to favour the system trends by taking advantage of the system "leverage" effects.

Our suggestion is that co-operation is the other side of competition and it is intrinsically tied to it. We cannot consider the one without the other, at all levels of human actions (individual, local, regional, global). Co-operation should not, however, be confused with "solidarity", with altruistic behaviour. Co-operation instead has to be seen as of direct interest of all the co-operating partners.

The contribution of this hypothesis to our "wisdom" of complexity is that the course of action of decision-maker is to assure that co-operation develops from other system elements to the conceived actions.

The case of a firm's technological innovation plan is an example of a difficult balance between competition of the various firm functions to use the scarce resource available and of co-operation to assure a better longer term prospective for the firm's development.

The design paradigm can itself be seen as a process of co-operation/ competition between the client and the designer where the emphasis is on the one or the other of the two according to the phase of the problem solving process. The requirement that the role of the client and of the designer be realised at a system level coherent with the problem 'dimension' is therefore another aspects of the general rules of avoiding too great unbalances (in this case unbalances between the ones that represent the demand and those that represent the ability to respond).

The competition/co-operation loop, to be effective, has to close at all levels of actions. Instead there is a tendency to separate the levels where actors have only to compete, from those where actors have only to cooperate. [2]

A general recipe to respond to the system challenges is therefore not only to *push for more co-operation but to be assured that competition/co-operation develops at all system levels*. This means working in synergy with intrinsic system forces, so to count on leverage effects.

The problem is particular difficult when proper actors/institutions are not yet developed as it is the case when considering "globalization challenges" when as a result new "global" sub-systems are emerging.

The problem of closing the couple competition/co-operation is particularly difficult with global issues because any approach to respond with solutions will produce diffused negative externalities as well as benefits. The diffi-

[2] An example of how this behaviour have increased unbalances come from the development of urban social environment. In the past different "classes" of peoples inhabited the same buildings where there were a clear distinction of the different social position of the tenants (even in the height of the different floors). However, the vicinity of poor and rich tenants made possible, on the other hand, a kind of co- operation-solidarity to develop (the poorer tenants supplying services to the richer ones). Unbalances were evident and undesirable. However, the result of shifting the responsibility to close the competitive/co-operation circle to an higher level (through social state solidarity) have produced urban ghettos (around social housings) shifting the unbalances to a much higher scale and making the situation even more undesirable and unmanageable.

culty comes from the fact that often the one that suffers of the externalities are not the same that benefit from the solution (see the case of transport infrastructure). The definition of what the problem really is and of its 'dimension' depends from the possibility to close the balance between the losers and gainers from the solution, to find a balance between competing self-interest and co-operating needs to find a solution.

10 Conclusions: applying the complexity "wisdom"

The word "***rational***" for a problem-solving approach bears an intrinsic analytical / reductionist flavour. To deal with complex issues such as the globalization ones, we need a better and less compromised word. We propose that the approach is better represented by the use of the word "***wisdom***".

Our basic hypothesis is that "*wisdom*" is available to allow us to deal with complexity.

To the building of this wisdom we have contributed by making few very general assumptions on the system characteristics:

- a self-similar characteristic of system structure - a system made of systems, made of systems, and so on;
- a dynamic pattern of punctuated equilibrium - the system will react to the need to change to adapt to environmental changes only when a large enough unbalance is produced;
- a self-similar aspect of co-operation and competition as "elementary forces" to move the system to respond to challenges.

From the experience of problem-solving in complex situation we have pointed out the "design paradigm" as the one that capture the intrinsic features of complexity. In fact the design paradigm accepts: vagueness of problem statement, strong interactions and blurring of roles of the different actors involved. Nevertheless, it provides a "recipe" to find ways out from an endless looping of interactions. Referring to the design paradigm permits to point to very simple general "wisdom" recipes (such as that of recognising the "dimension" of the problem in order to choose proper actors) for the behaviour of each actors, even before starting the real problem-solving activity. It also provides more detailed "wisdom" recipes for problem solving.

The three general hypothesis on system characteristics plus the design paradigm help to define a corresponding structuring of decision-making to respond to challenge:

- complexity problem - no matter how great and novel the complexity - can be considered from the practical point of view as having the same type of structure, a system with few hierarchical level delimited outside by an environment and inside by unbreakable components;
- when an actor has already emerged to react to a system challenge, he needs to consider the passing from the perception of the challenge to the specifi-

cation of the terms of reference of the problem to be solved as the first important aspect of decision- making. And to do this he has first of all to delimit the system on which to act. The design paradigm can be used at a meta-level to perform this task;

- there are different ways and actors that can react to a system challenge. To assure a better response one should first of all decide what is the best way to delimit the part of the global system that has to react to the challenge. A meta-design approach can be applied to this effect to the meta-problem whose output will be the selection of the actors to takes the challenges as their owns;
- to assure greater efficiency and probability of success to the action plan one should try to make use of the inertial trends of the system evolution. It is hinted that system dynamics develops from the basic interplay of co-operation and competiton between the system elements at all the level of the system structure. A clever decision-maker should therefore assure proper development of the competion/co-operation where an unbalanced between the two terms of the couple has developed.

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