Forecasting and Backcasting to Manage the Changes: an Anticipatory View

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Abstract
When the current performances of a social system are reckoned as unsatisfactory and not complying with its expected evolution or if their trends appear to result in an unsustainable future, the problem consists in defining a change for reaching a better behaviour. Significant changes in the evolution are possibly obtained by discontinuities, which may be concerned with drastic changes in the policy and/or in the system structure.
This paper introduces the paradigm of managing the changes by discontinuities, which we can identify and treat by computer simulation according to a heuristic approach, which involves forecasting, backcasting and optimization tools. Finally, such an approach is discussed from an anticipatory point of view.
Keywords: Backcasting, Anticipatory Systems, System Dynamics, Social Systems, Social Change.

1 About the Problem

A Social System is an integral part of the actual world involving human activities and, as such, conditioned by human behaviour. From a system engineering point of view, it is also an event-driven, adaptive, recursive and self-referencing economical, organizational and technical complex system, with physical constraints.

The evolution of a Social System shows discontinuities (Dechert, 1968) occurring when changes in quantification and/or in structure are required in the related dynamic model. The literature offers various examples defined as evolutionary gap, critical point, bifurcation, self-organization, etc. In this context, the basic concept is that a model development, as predictable by forecasting simulation, is not able to identify and justify discontinuities that give evidence of innovation quite off regular trends.

In fact, evolution is supplanted by innovation ("Imagine the future, then make it happen", Hamel and Prahalad, 1994). Indeed, if the actual or expected system behaviour appears be unsatisfactory, the vision of a more advisable system must be conceived as a target to be achieved by a new sustainable strategy: such transition between the two distinct System identities implies a discontinuity process.

Computer simulation as a decision support offers a tool for managing the change, if we can treat discontinuities; in other words: discontinuity becomes the way for the change. The problem thus deals with an efficient identification of discontinuities to be adopted for carrying out the required change of a social system.

Some necessary background consists in the analysis of both data series and historical explanation; from which recurrent discontinuities may be classified together with the causal relations across the drastic (r)evolutionary phase. The analogy paradigm allows proposing a discontinuity for the desired change, which appears as most recurrent in historical records.

In terms of models, discontinuities are associated with discrete events attributable to changes in policies and/or in state variables, or even to appearance of new ones along with related structural variations. A System Dynamics approach (SD) offers the basic simulation environment[1], because it seems to be adequate with regard to some inter-operation facility as a tool for communication between stakeholders within their Social System re-planning.

The operational problem of Change management will be here at first dealt with by a heuristic procedure, then reconsidered from the anticipatory point of view, as applicable.

2 The System Dynamics Approach

A system, whose dynamics be reproduced by a hybrid model, can be described by differential equations and logical relations (about discrete events), where equations may not be analytically integrated but can be expressed as difference equations: thus the discrete model becomes a recursive algorithm suitable for obtaining approximate solutions. The system model is generally stated as:

$$X(t+1)=R(X(t), X(t-1), X(t-2) \dots , P, U(t), U(t-1) \dots , N(t)) \qquad (1)$$

where X: state vector, U: control vector, P: time-independent parameters, N: noise vector, R: model structure. The recursive procedure requires initialisation, too.

Since a controlled system is considered, the target state X_b must be also set as final state. Constraints on the time for reaching the target may be not explicitly set.

Introducing a policy C, the control problem may be simplified by stating

$$U(t)=C(X_b - X(t)). \qquad (2)$$

The independent variable may be the "inside" time of simulation, so as the real time for an on-line control; the latter case may need anticipatory methods. Anyway, the integers related to the time show the number of the discrete steps Δt to be considered.

The System Dynamics (SD) approach simplifies the time indication by stating:

K as current instant, $J = K - \Delta t$, and $L = K + \Delta t$.

Accordingly, the model does not explicitly show variables before J, which are taken into account, if necessary, by means of macro-statements (delay functions), which also

[1] The foundations of this methodology can be found in Forrester (1961, 1968), Coyle (1977), Randers (1980) and Richardson and Pugh (1981). For an updating oriented to the software of the PC era, see Coyle (1996) and Sterman (2000).

need to be initialised. In practice, the time-independent parameters are called constant P and state-dependent $P(X)$. In conclusion, the SD model is of the type:

$$X.k=S(X.j,\ P,\ P(X.j),\ C,\ N.j) \tag{3}$$

where structure S contains the relation involving remote variables, too.

If the model in eq. 3 is identified by observation of the actual system and by data series in the interval $t_0' \div t_0$, the practice suggests t_0 be the latest possible, for a better forecasting, while t_0' be not so remote as to involve past discontinuities.

The typical SD problem consists in defining a policy C capable to achieve a certain goal within time interval $t_0 \div t_f$, if such policy is applied at t_0. A most important use of SD should be in policy design, that is, the rules that should govern decisions.

In enterprise managing the goal might imply a target state X_b, more generally the goal may be a scalar output as Index of cost or performance to be minimized or maximized in parameters space C. Usually the policy parameters represent the resources allotment.

The search-based optimisation tools of SD software packages allow to achieve quite easily and rapidly an optimal policy, which may be local or global. Anyway, forecasting simulation methods allows to explore the future of different policies (on "futures"), together with various scenarios according to different hypotheses about the model quantification related to parameters and exogenous inputs.

Obviously, a SD approach introduces as a discontinuity only the change of policy applied at t_0. Furthermore there is a time validity limit of the interval $t_0 \div t_f$: the forecasting is significant *iff* the actual world does not change until t_f so much to require a new model.

In practice, time interval $t_0 \div t_f$ often equals about one-third[2] of $t_0' \div t_0$, but time validity depends on the nature of considered phenomena: for instance, cultural parameters may be invariant for few centuries, technical systems involving material and energy for some decennia or more, systems related to Information Communication Technology (ICT) for some years.

3 The Backcasting Approach

In attaining desirable futures, BackCasting Analysis is linked to both present and anticipated future problems (Robinson, 1990): backcasting is anticipatory by its very nature, virtually regarded as a reverse simulation of the model stated in eq. 3 from t_0 until $t < t_0'$.[3]

In a SD environment, backcasting has been proposed as a validation test[4] and an auxiliary tool in historical researches (Piattelli and Bianchi, 1999).

[2] This rule of thumb has been suggested by S. Bremer (Meadows *et al.*, 1982, pp. 232-236).

[3] As antonym of forecasting, backcasting deals with the backwards simulation of a model outside the time-boundaries of the reference data.

[4] Backcasting techniques became an important topic of the *Limits to Growth* debate (Meadows *et al.*, 1972): The Science Policy Research Unit (SPRU) at the University of Sussex tested in backcasting the world model developed by the System Dynamics Group (SDG) at the Massachusetts Institute of

However, SD software packages do not allow performing straight backcasting procedures, therefore problem solvers must resort to middleware arrangements and use general-purpose languages and specific math tools.[5]

Today, the term 'backcasting' is prevalently referred to analyses of 'futures' studies, whose distinguishing characteristic is the concern about how such desirable futures can be attained. It is thus explicitly normative; involving "working backwards" from a particular future end-point to the present to determine what policy measures would be required to reach that future(s). So much so that BackCasting is at last considered a useful tool on the road toward sustainability for imagining a desired future and for reaching it. To make an example, the Swedish School focuses both the qualitative future vision side of backcasting (Dreborg, 1996) and its approach based on computer simulation as a means to explore options on how to meet that goal (Höjer and Mattsson, 2000).[6]

Modelling a sustainable system might appear trivial when dealing with renewable resources (Hartley, 1993), because they must be exploited at a level below the related carrying capacity. The exploitation of non-renewable resources should not reduce any carrying capacities of the renewable ones and take into account the needs of future generations.

Significant renewable resources are locally different, while decisions about the exploitation level of non-renewable resources depend mainly on cultural aspects, which also are locally different. Therefore any desirable future appears as a local target, while global problems of sustainability should only state global constraints on the local sustainability. In conclusion, a contingent adjustment by feedback procedures can be sought for obtaining a model from a future vision.

Since the model of the current unsustainable system is given by X (eq. 3), then the model of the desired sustainable system is likewise formalised by X' (eq. 3') with a future vision at time t_b:

$$X'.k = S(X'.j,\ P',\ P'(X.j),\ C',\ N'.j) \tag{3'}$$

where formalisation, quantification, and initialisation are somehow different from those of the model in eq. 3, which may not be validated by behaviour comparison with data series in a time interval including t_b.

Furthermore, the time length from today to such future prevents from a comparison with forecasting within the time validity of the present model. Finally, the considerations on time length $t_0 \div t_b$, and on the significant changes for obtaining a future model, suggest the need of discontinuities for the transition from the present system to the future one. Anyway, model in eq. 3' can be used in reverse simulation,

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Technology. The SPRU/SDG-MIT backcasting controversy can be found in Cole and Curnow (1973a, pp. 113-117; 1973b) and in Meadows *et al.* (1973, p. 139).

[5] Limits and suggestions for backcasting procedures in SD environment have been outlined by Piattelli and Bianchi (1999).

[6] The Swedish view stems in part from the qualitative approach to energy-oriented futures studies named "backwards-looking analysis" developed by the Canadian school in the seventies (Robinson, 1982, pp. 337-338).

which is not strictly speaking a backcast[7], for reaching an intermediate state X'_f, within an assumed time validity of the model itself, by the same procedure by which the forecast reaches a certain X_f.

4 The Heuristic Approach

Social systems, which can rarely be regarded as autopoietic and homeostatic, most holistically show strong perturbation and feedback effects, should feature adaptive and predictive but also anticipatory characteristics as some of their integral components. Related model simulation would thus be run on forecasting (direct time) and backcasting (reverse time) modes that appear quite complementary, since:

- ForeCasting implies perception of actual conditions; reactive behaviour; focus on quantitative parameters; downstream macro-indicators; management by objectives; indication of need for a change; "what if ?";
- BackCasting implies vision of future desired scenarios; proactive behaviour; focus on qualitative variables; upstream orientators; management by results; implementation of a change; "what ?".

As a matter of fact, a proper strategic planning must combine fore and back casting methods: indeed social problems are reckoned by "missed target" hints in forecasted trends, possible solutions are investigated by backcasting focused on desirable futures and means/modes to realize such scenarios, thus firstly on necessary and feasible changes to the system, quite often by breaking current trends.

Basically, the final problem consists in managing the feasible transition from the unsustainable X (eq. 3) to the sustainable X' (eq. 3'); it is thus necessary to identify:

- an intermediate state X_f and the related policy C (by forecasting)
- an intermediate state X'_f and the policy C' (by backcasting)
- the discontinuity for a transition from X_f to X'_f (by comparison of X_f vs. X'_f).

The assumption $t_f \geq t'_f$ is acceptable because any less remote desirable state can be considered to avoid time gap or overlap.

A change in the state variables set can occur in the transition, some might disappear while others might be introduced, but that does not necessarily imply a change in the model structure S. Thus, if the common subset $Z = X \cap X'$ is defined, the former $X \notin Z$ will disappear, while the latter $X' \notin Z$ will appear.

With reference to such common subset Z, the problem becomes to find at t_f a common state Z_f which can be reached both by the policy C in the forecasting interval $t_0 \div t_f$ and by the policy C' in the backcasting interval $t_b \div t'_f$.

The considered model, controlled by the invariant policies C parameters, is assumed to satisfy the requirements for uniqueness of the pattern (Wright, 1973, p. 1087), along with the freedom in choosing t'_f and/or an intermediate desirable state, makes Z_f reachable for both forwards and backwards patterns. SD tools provide a relatively easy

[7] We can only assess a consistency between the future vision and its possible model: there is not extension of reverse simulation beyond a well-known pattern.

procedure for identifying both state Z_f and policies C and C': the two models are simulated as they were synchronous and for optimisation is applied the cost index[8]

$$\texttt{Index} = F(W_1(Z_1\text{-}Z'_1),\ W_2(Z_2\text{-}Z'_2),\ \ldots,\ C,\ C') \tag{4}$$

where W_i are possible weights to be applied to state differences.

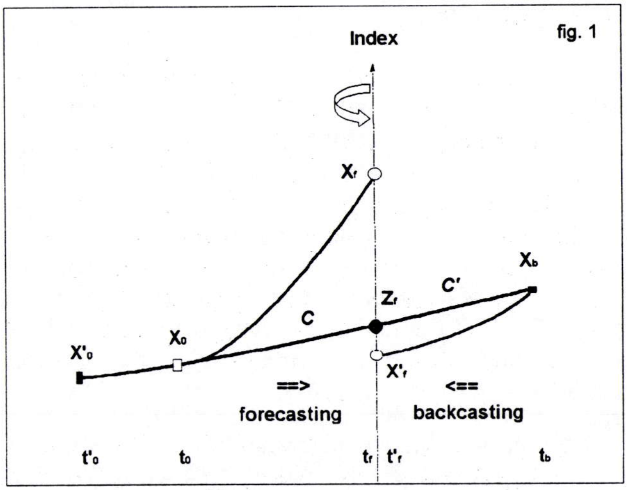

Fig. 1: Identification of a discontinuity

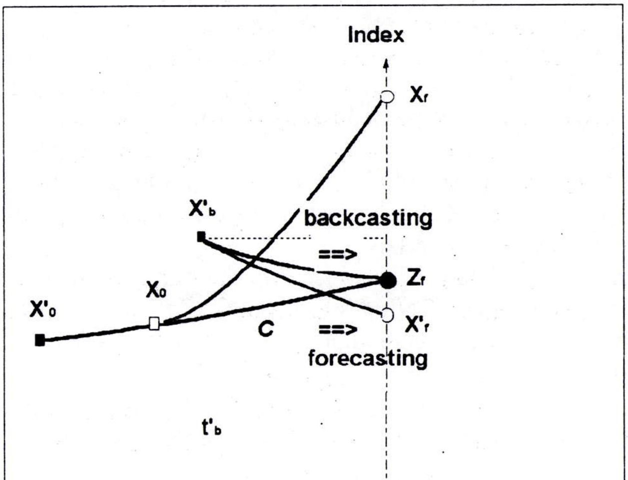

Fig. 2: Identification of a common intermediate state Z_f

Optimal policies $\hat{C}$ and $\hat{C}'$ are therefore implemented to obtain at t_f certain subsets $X_f \notin Z$ and $X'_f \notin Z$, being $t_f = t'_f$. Fig.1 visualizes this heuristic procedure.

[8] For example as in our case study of CO_2 emissions in the transportation system (Piattelli *et al.*, 2001).

A comparison between such policies allows to defining the discontinuity. A common state Z_f can be reached by synchronous runs (direct/reverse Δt) procedure as shown in fig. 2, evidencing the gap. Such discontinuity implies a transient during which the disappearance of $X \not\subset Z$ follows the appearance of $X' \not\subset Z$.[9]

The transient interval can be regarded as the whole $t_0 \div t_b$ (fig. 3a) or even a shorter period (fig. 3b), depending on the kind of changes and the expected availability for the new states $X' \not\subset Z$. Fig. 3 shows a visualization for a single state variable.

Fig. 3a may show, for instance, the replacing of private cars by bicycles in the urban area, with bicycles already available, where a long time is required because of the cost for re-designing the urban layout and carrying out the new structure.

Fig. 3b shows, for example, the replacing of gasoline-powered private cars by fuel cell cars in some urban area, being t_t the expected time of fuel cell commercial availability, and $t_t \div t'_t$ the transient interval. The pattern of the transient depends also on the chosen policy, defined by optimisation for a set index. Such policy may alter the pattern of Z; therefore an iterative adjustment procedure is generally required.

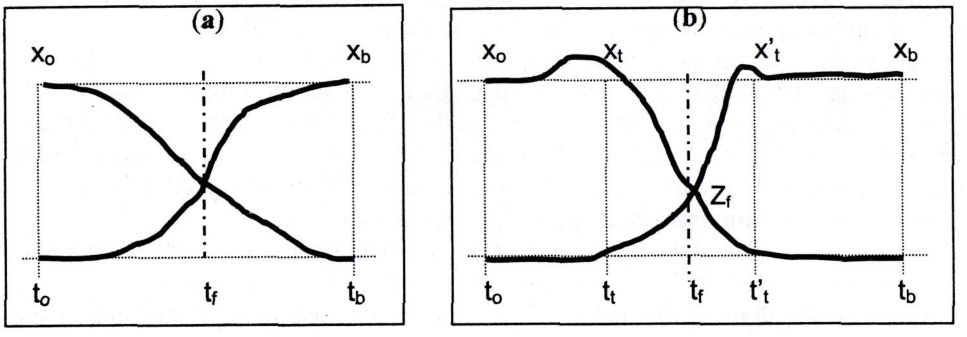

Fig. 3: The length of discontinuities: whole (a) and short (b) transient interval.

A specific freight Transport model, called CarbonTaxMod (Piattelli *et al.*, 2001), was recently developed and its extensive simulation implemented by COSMIC-COSMOS sw packages (Coyle, 1996, 1999), with optimisation procedures akin to those used for backcasting. In fact two distinct model are used: one for "regular" trends of crude-oil price and the other "disturbed" by a trend-breaching predicted oil-shock, mostly similar in structure except for petrol price assessment.

Each model features some Cost Indices (eventually optimised) and seven Control Parameters, which then indicate best fitting policies for the change. Concurrent simulation runs both model simultaneously and the absolute values of differences between related indices are minimised. The outcomes are indeed the sought optimal

9 An example is the case study based on the Kuhn's theory of scientific revolutions paradigms (Wittenberg and Sterman, 1999); another one is our modelling exercise on the change of war galleys type in the ancient Mediterrean (Piattelli *et al.*, 1996).

policies to get over the oil crisis, viz. in the final step (flexible enough) strategies are identified that link such critical situation with a desired future sustainable scenario.[10]

5 From an Anticipatory Point of View

Dubois (1999) defines weak and strong anticipations. Weak discrete models can be related to Rosen's definition: "An anticipatory system is a system containing a predictive model of itself and/or of its environment, which allows it to change state at an instant in accord with the model's predictions pertaining to a latter instant" (Rosen, 1985). Decisions about present actions are based not only on earlier and present states but also taken on expected future states, as predicted by such internal models.

In fact, (weak) anticipation is a characteristic not only of living systems, but is also a fundamental property of physical systems, and can be as well found in man-made technical and organisational systems: for instance, the discrete on-line control in engineering applications usually requires a built-in predictive model[11], where the FeedForward anticipates just one future state (on error due to current disturbance) and such prediction guides the system behaviour (Ekdahl *et al.*, 1995).

Strong anticipation is generated by the recursive discrete system itself, which computes its current state as a function of its past, present and future states, "evolving from an initial state to an implicitly embedded final state". Then, "incursive" is a neologism for "implicit recursive" defining that system, which is self-referential because it computes its future states from itself and not from a prediction-based model (such as tennis playing that needs space-time strong anticipation).

A difficult but essential concept is the clear distinction between a real system and its model, possibly embedded in its sensing and decision making component.

A first approach to solving the problem of discontinuities, from an anticipatory point of view, is offered by the following example (Dubois, 1999):

$$X(t+dt) = X(t) + \Delta t \cdot R(X(t), P) \tag{5}$$

or, according to SD time notation:

$$X.k = X.j + \Delta t \cdot R(X.j, P) \tag{6}$$

The forward simulation from a certain X_0 implies that $X.k$ is constant in the interval time $K \div K + \Delta t$, according to the Forward-Euler's integration method.

The reverse or backwards simulation from a certain state X_f is obtained by changing R into $-R$, or by substituting $-\Delta t$ for Δt

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[10] The fully-commented source code of these experiments can be downloaded at the following URL: http://www.ge.cnr.it/CST/M&S/DSS/papers/CarbonTax/.

[11] A typical case occurs when the computation time for obtaining the future control actions is too long in comparison with the actual dynamical system. Another case occurs in regulation problems with a significant driving noise (as example the dynamic positioning of ships in open sea), if the required accuracy does not allow to wait for noise effects and the noise itself may be gauged (the wind in the example).

$$X.k = X.j - \Delta t \cdot R(X.j, P) \quad (7)$$

with $X.k$ constant in the time interval $K \div K - \Delta t$

$$X.j = X.k + \Delta t \cdot R(X.j, P) \quad (8)$$

and finally at the current time instant K:

$$X.k = X.L + \Delta t \cdot R(X.k, P) \quad (9)$$

where $L = K + \Delta t$.

Let's quote directly from Dubois (1999): "This represents a self-referential anticipatory system ... For Δt tending to zero, the forward and backward systems tend to the same differential equation. The anticipation comes from the numerical discretisation of the differential equation".

Forward and backward evolutions show a gap or a quantitative difference, because forward simulation is delayed, while backward simulation is anticipatory. Such difference might be called "hysteresis" by analogy with the direct and reverse magnetization pattern of iron.

6 Computation in Anticipation and System Dynamics Environments

When a future goal is defined as the desired state of a discrete system, an anticipatory hyperincursive model appears to be feasible if a decision process is capable to select one of the self-produced multiple choices, comparably to the single one produced by incursive systems. As shown by the previous simple example (eq. 9), both backcasting from the future desired state and forecasting from the present state to the discontinuity could be regarded as an anticipatory approach because such transitional state is an intermediate future goal, too. Finally, the discontinuity itself could be reckoned as an anticipatory problem, if also a change in the state variables occurs and it is not matter of approximation in differential equations, because in this case a goal is defined.

Well and good, then? Not exactly, because some difficulties arise about the concept itself of anticipation related at the level of its application. The first level question can be reported as: "What is actually anticipation in the proposed problem?" Historical considerations about the evolution of social systems show that such systems are generally non-anticipatory, according to both the weak and strong definition of the term, because they tend to an unsustainable development, as it today occurs.[12]

In other words, such systems are unable of endo-anticipation. Then, the question becomes if we can provide for an eso-anticipation. Formally if such systems are predictable, we can predict if they will become capable of endo-anticipation.

The last statement appears somehow analogous to that of the Swedish School, related to backcasting: the fundamental point does not concern the implementation of an adequate decision support for managing the change, but regards the way of changing the

[12] The 'arrested' civilizations (Polynesians, Eskimos and Nomads, Osmanlis, Spartans), according to the Toynbee (1970) classification, show the few cases of sustainable societies in history.

attitude of social actors in order to obtain their acceptance of backasting tools. There still exist a negative position about "future vision" against forecasting and modelling, based on the assumption that a forecast is appraised by stakeholders as an unavoidable future, and that models are considered mainly as tools for forecasting.

The anticipation approach, as a conceptual method, focuses the future goal and patterns and, therefore, can be easily accepted also in terms of computational applications.

At the second level, a SD environment was chosen for developing Decision Support for managing the changes by carrying out discontinuities, because its purpose is to explore the effects of alternative strategies and to design improved policies by the means of an appropriate simplification of the causal processes in the system, to be conceptualised together with the involved actors.

In fact, the SD formalization appears more adequate than others in terms of communication support between systemic specialists and social actors. From this point of view, the mathematics involved in the anticipatory computation appears as a difficulty for communication. However, the proposed heuristic approach to the problem cannot be implemented within the limits of SD environment, at least because the current software does not allow to backcast a model, neither to adequately treat discontinuities in its structure.

Therefore a third level of difficulties arises in practice, because mathematics should be as transparent as possible from the point of view of decision makers.

Let us reconsider the heuristic approach earlier proposed to manage the Changes in social systems by a Discontinuity praxis. The intermediate state Z_f of common variables, viz. those existing both at present and in the desirable future, represents indeed the common target of fore and back casting. It can be reached after by adopting an optimisation index (eq. 4) that takes into account the differences acceptable for single (specific) variables. The very same optimisation procedure provides those strategies apt to realize the transition from the present to the future Z_f (figs. 1, 2).

Within a SD context, such heuristics produces two trajectories (fore and back casting) aimed at the same target, apart from allowable errors. Such result appears to be conceptually equivalent to that obtainable through a strong-anticipation computing (SAC), as a consequence of an optimisation that imposes the states to be reached through the target.

The policies thus settled, C by forecasting and C' by backcasting, cause the evolutions of non-common variables $X \not\in Z$, which end, respectively, in X_f e X'_f in concomitance with Z_f. Such terminations X_f e X'_f are not appointed targets but merely the outcomes of forecasting models, consequent on C and C' policies. This procedure relates indeed to weak-anticipation computing (WAC).

Theoretical considerations would caution against the possibility of some non-common variables not to be controllable by C and C' policies, but this case is here neglected because the optimisation process should actually take into due account any side effect upon such variables.

In the given examples about the duration of transition discontinuities, an adequate policy must discourage private car-drivers from unnecessary traffic even if private alternate vehicles are not yet or not sufficiently available, such as fuel cell cars or merely bicycles.

Finally, the discontinuity management must be pointed out. The heuristic approach within SD does allow defining the initial and final states of non-common variables, which are to disappear or anyhow be reduced to acceptable levels. It also allows defining the initial (usually empty) and final states of those variables that are then to appear. Such two levels cannot be decoupled, since they, together, must guarantee utility: thus, the two dynamics are correlated. Their correlation depends on the period of transition, under feasibility constraints, and on the very same utility (fall-out effects, costs, etc.) that can be expressed as an optimisation index. Once again, the SD heuristic approach seems to be equivalent to a SAC application.

With academic examples, as shown (eq. 9) by Dubois, Anticipatory Computing somehow appears as a formal consequence of shifting from differential to difference equations and that might throw doubt on its applicability to logic relationships dealing with events, such as in the case of discontinuities. Nevertheless, we do not face such problem within this proposed schematisation that subdivides the procedure in segments compatible with Anticipatory Computing: in particular, every discontinuity is regarded as a continuous transition between its two delimiting events.

7 Conclusion

This paper deals with the managing of the changes in the social systems through evolutionary discontinuities, which may be identified by computer simulation.

Such discontinuities may be in the policy, according the System Dynamics approach, that means a change in the control parameters in the model and/or in the appearance of new variables, that means an eventual change in the model structure and quantification.

A heuristic approach is presented for the identification of discontinuities, adequate for reaching a preset future. It is based on the complementary use of forecasting, backcasting, and optimisation techniques. Finally, the matter is reconsidered from an anticipatory point of view.

Such heuristics consists of three phases. Current and final states are the input of the first phase, whose output is the intermediate transition state associated to a discontinuity together with the policies meant to reach such state from the present and from the (desired) future. This stage exploits fore and back casting plus optimisation techniques: it appears equivalent to a treatment with a SAC appliction.

The next phase deals with the transition by simulating a discontinuity, uses optimisation techniques and, likewise, appears to be equivalent to a treatment with SAC.

The last phase concerns the determination of a discontinuity, i.e. of both the variables that appear and the variables that disappear or are minimised. It is conceptually equivalent to a WAC case: indeed, at this stage targets are not assigned but are consequent on provisional (fore and back casting) models, which bring about common variables to coincide at the intermediate state associated to a discontinuity.

On that basis, our further research developments have been planned in terms of:
- experimentation of the proposed heuristic approach within a SD environment;
- comparative experimentation with Anticipatory Computing approaches;
- methodological investigation about possible relations between strong anticipation and optimisation in the definition of control strategies.

A comparative study shall then be presented about some classic dynamic models, such as those of the prey/predator with three populations in series in the food chain, and of the tragedy of commons with a resource and two exploiters, where manageable Discontinuities are related to the Change of (one and two) populations of predators/exploiters.

If the afore-said conceptual equivalence will be corroborated, such study may also result in electing which of the two approaches can be defined more "elegant", i.e. "simple", in the sense attributed by Von Neumann to mathematical models.

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[14] A preliminary version of this paper is available at the following URL: http://dieoff.org/page74.htm.
[15] A preliminary version is available at the URL: http://www.tft.lth.se/kfbkonf/4Hojer_Mattson.PDF.
[16] The printed version of the Proceedings contains only four-pages extended abstracts; the full paper can be reached through the web-site of the Conference <http://web.mit.edu/jsterman/www/SD96/home.html>, or, directly, at the following URL: http://www.ge.cnr.it/CST/M&S/Polis/.
[17] This report is available at the following URL: http://www.ge.cnr.it/CST/M&S/DSS/papers/bkc/Retro/.

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[18] A preliminary version is available at the URL: http://web.mit.edu/jsterman/www/SDG/self.html.