Conceptualization of Social Systems: Actors First

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Abstract

Social systems are formed by actors whose actions and decisions form a complex structure of continuous inter-actions that shape the performance of those systems. System dynamics models help to design and redesign new configurations of a system in order to improve its performance, which for social systems requires thus intervening and modifying actions and decision-making processes. There are several ways for building system dynamics models. Being a heuristic, a powerful advantage of system dynamics is that it does not come with a "recipe"; instead, each modeler, according to purposes, particular problem, interests, etc. can build a model in different ways. In particular, the conceptualization stages are critical since they form the base for imagining the system and formulating models which later on serve as tools for developing understanding and taking actions to improve the system. However, it is not easy to find explicit guidelines that consider a full and systematic analysis of actors (in terms of their actions and decisions) as a source for conceptualizing the social system that dynamically "produces" the problem to be modeled. This paper presents a methodological guideline for conceptualizing models of social systems intended to address the actor-driven nature of such systems. The emphasis on decision-making in social systems serves as a heuristic that guides the model building process and leads to a shift from "variables" to "decisions rules" and "actions". Such heuristic favors the creation of policies and interventions that rest on the power of actors to change their own system.

Keywords: conceptualization, methodology, model building, social systems, actors, agency.

1. Introduction

System dynamicists are frequently interested in modeling *social systems* (e.g. a firm, a corporation, an university, a football team, etc.), that is, purposeful systems formed by decision-making actors that act according to their own interests and goals. That is a very special characteristic of those systems: both their elements (actors, institutions, organizational units, individuals, etc.) and the whole system have the ability to make choices according to goals, interests and purposes, as opposed for instance to deterministic systems (e.g. a clock) in which neither the whole system nor the parts are purposeful, or animate systems (e.g. a person) whose parts do not display choice (Ackoff, 2001; Ackoff & Gharajedaghi, 1996). Hence, the interactions in a social system correspond to those purposeful decision making processes that convert information into action—such is the definition of "decision making" of Forrester (1961)—through the exchange of resources, materials, information, meanings, communications, etc. These systems produce problems that interested parties intend to resolve. Consequently, the redesign and improvement of social systems require changing the actions of their own actors, new arrangements, new ways of organizing and doing decision processes. Such transformations can be boosted through the construction and use of models. System dynamics (SD) allows to build explicit models of such social systems in order to change mental models and enhance our understanding about the dynamics of a system in order to improve its performance and accomplish desired goals. Building models of social systems requires then explicit knowledge about the dynamics of the social interactions of the modeled system (Vriens & Achterbergh, 2006).

The modeling process creates knowledge that relates the structure of systems with their performance in order to improve it in desired ways. How to build these models? The heuristic mode in which SD has traditionally approached this question has opened a variety of options and methods, which is one of its distinct advantages since model building can be oriented according to the purposes, goals and interests of modelers. Those methods are explicitly available and described in the rich literature of SD and help to guide (both beginners and experts) the modeling process, which expresses the breadth of the field. However, in spite of such available sources, "sometimes making sense of all of the material is difficult, especially for novices in the field" (Martinez-Moyano & Richardson, 2013, p. 105). Nevertheless, there is always a shortcut: system dynamics models seem easy to build. And perhaps it is true. Apparently the point is to find the relevant "variables" that describe a problem (keeping in mind a special treatment for stocks and their flows), identify auxiliary variables and parameters, connect these variables in appropriate ways, run some tests and develop an understanding that relates the model structure with its behavior. But there are risks involved if we take lightly the apparent easiness with which SD models can be built. For introducing his "Guidelines for Model Conceptualization" Randers (1980) stressed that "few beginners resist the temptation to follow what is felt to be the 'natural' approach to modeling: a headlong rush into description of the real world in the form of flow diagrams" (p. 118). Modern SD software packages paradoxically may risk matters further since indeed it is uncomplicated to connect in a computer screen diverse variables with causal links and build any model with them, which echoes the old criticism of Maloney: “With a mouse, and just enough self-restraint not to try connecting everything to everything... ba-da-bing, ba-da-boom, you’ve got a model” (p. 305). Such simplicity may lead beginners to become overconfident and oversell their skills (Meadows, 1980), let alone the possibility of building poor models.

The mentioned risks may become especially problematic if the modeler is addressing a social system since it is easy to exclude its purposeful and decisional nature. For instance, let us say that the model of Figure 1 is intended for modeling the problem of decreasing revenue in a particular organization (a social system). The model displays a first small conceptualization of such a system with 4 variables and 5 feedback loops (though there are more) that may help to understand the dynamics of revenue. However, it is not easy to appreciate in the model decision making processes attached to concrete actors, either through the variables or through the feedback loops. Those variables are abstract concepts (bureaucratization, organizational pressure, revenue, personnel) that apparently have causal effects on others. Let us suppose that we suspect (or indeed later find) that a specific loop (say the one labeled as “Can´t take it”) or some specific variables are critical for changing the behavior of revenue. How to actually change such causal effects in the real system? How to implement changes that affect those variables? How to modify the “strength” of the loop? Exactly how the system “produces” the behavior of revenue? Through which actions? If we want to change that behavior, *who* can/should do what and how? Perhaps in a later modeling stage these questions could be answered. However, the explicit orientation of a model of a social system in terms of actors and decisions starting from the conceptualization stages may facilitate a later model formulation that accounts for the very structure of a modeled social system: the decision processes carried out by purposeful actors.

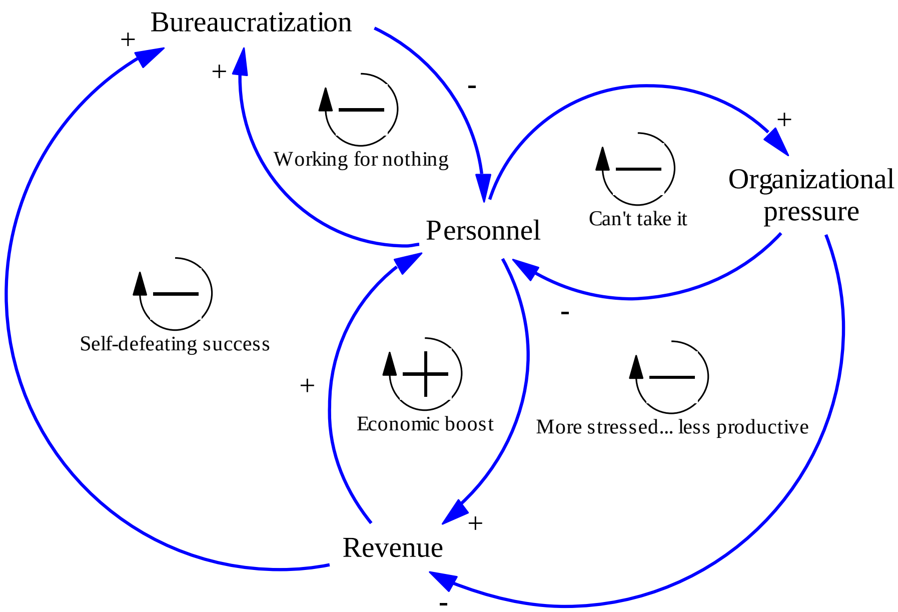

Figure 1. A model of a social system missing explicit decision-making

Unfortunately, it is not easy to find model building guidelines that stress such decisional character of social systems at the early conceptualization stages. Usually the language and the conversation along a modeling processes favor terms like “sectors”, “variables”, “factors”, “equations”, etc. over “actors”, “actions”, “decision”, etc. This bias can be seen indeed in the way in which usually system dynamicists express how they conceive the modeling process. In the revision of best modeling practices that Martinez-Moyano and Richardson (2013) made among top SD experts, their results about which core activities are regarded as highly important for system conceptualization and model formulation do not mention any suggestion to explicitly address actors or decision-making processes within a model building process. Although that study is intended to be wide enough to serve as a guide for building diverse types of models, using different modeling tools and for different purposes, overlooking actors and their actions entails the risk of ending up with a model full of variables that may hide possibilities through which the modeled system can be in fact improved: the action of decision-makers. A further and major risk is to end up in the error underlined by Ackoff (2001): mistaking a social system as a deterministic system (as a sort of machine whose main challenge is reduced to find the “correct” *variables* to “push”) by building an abstract model disarticulated from such agency that distorts the defining characteristic of social systems: the purposefulness of their parts.

There are different ways to organize and “run” a modeling process. Barlas (1996) suggests 6 typical major steps that match a wide spectrum of how the modeling process is described in SD reference works (Table 1); these steps are usually understood in terms of iterative and cyclic regimes, see (Martinez-Moyano & Richardson, 2013). Although such categorization varies across modelers, tools and purposes, we will use it for placing our proposal in context. We will focus on “model conceptualization", perhaps "the most important and least understood of all modeling activities" (Sterman, 1986, p. 76). For now we can take the classic work of Randers (1980) as a reference point for demarcating model conceptualization: once a problem and the questions to be addressed have been identified, the conceptualization seeks to picture basic mechanisms (in terms of feedback loops) as powerful organizing concepts for explaining the problem to address, "to arrive at a rough conceptual model capable of addressing a relevant problem" (p. 131).

Typical stages in model building
1. Problem identification
2. Model conceptualization (construction of a conceptual model)
3. Model formulation (construction of a formal model)
4. Model analysis and validation
5. Policy analysis and design
6. Implementation

Table 1. Typical stages in model building, from (Barlas, 1996). We will focus on model conceptualization.

Interestingly, the study of Martinez-Moyano & Richardson found that "although *what* model developers do is important, *when* they do it also seems to be critical" (p. 119). In this paper we suggest that identifying explicitly actors (and their relevant decisions) in the *early* stages of the modeling process—as the base for *conceptualization*—helps to build models of *social* systems, that is, models whose structure and variables capture the purposeful, action-oriented and decisional nature of this type of systems. We introduce a methodological guideline for conceptualizing SD models built on the assumption that a problem to be modeled is driven by a social system constructed through actions of actors. This consideration develops a heuristic that helps to guide and improve the modeling process and favors to achieve relevant and action-oriented results through the design of policies and interventions that rest on the power of actors to change their own social system.

2. System Conceptualization in Model Building

How to build an SD model? This is always a recurring question, especially for philosophers and beginner modelers. Model building is more an art than a fixed technique. It has to do more with creativity than with algorithmic methods. Perhaps only experience and iteration strengthen modeling skills. However, practical guidelines have been available from the first years of SD. For instance, Forrester in Industrial Dynamics (1961) devoted the fifth chapter to setting "principles for formulating system dynamics models", "principles" in the sense that there is no "magic recipe" but only useful heuristics that might help. Some of these principles are:

- From his engineering roots he knew that models are built according to a purpose. "Questions to be answered control the content of a model" (p. 60).
- Model building should not be restricted to include only those aspects that can be solved analytically but also "all the facets that we should consider essential to a verbal description of the phenomena under study" (p. 60).
- The model should account for the information-feedback structure that "gives rise to so much of the interesting behavior" (p. 61). This aspect means for him to consider not only closed-loops but also time delays and relevant accumulations (both physical and information reservoirs).
- The model should correspond to real-system variables, measured in the same units.
- He suggested to identify six distinct networks that "represent the grossly different types of variables that will be encountered" (p. 70): orders, materials, personnel, money, capital equipment, and information channels (this latter network interconnects the other ones). He recognized that this classification is arbitrary but it helps as a guide to identify variables.

These first guidelines point at "variables" as organizing concepts for building a model, e.g. the importance of identifying accumulation "variables", the correspondence to real-system "variables", the six networks for identifying "variables", etc. Forrester's work always included actions of actors through "policies" (decision rules) and indeed he always stressed that policies (in the sense of "decision rules") define the logic for equations; however, in his initial methodological principles there is no explicit suggestion to think in terms of actors and decision-making processes as a guide for steering the modeling process. In fact an emphasis on decision-rules may lead to suppose that all relevant actors' actions become implicitly included in a model.

One of the first clear-cut guides for SD model building was proposed by Randers (1980) who divides the process of modeling in four iterative stages:

1. Conceptualization: Definition of problem and question to be addressed, time horizon, organizing concepts, model boundary and verbal description of feedback loops that may cause the reference mode.
2. Formulation: Postulation of detailed structure, stocks, flows, parameters.
3. Testing.
4. Implementation.

In particular for the conceptualization stage he suggests to start with a recognized step by any system dynamicist: the reference mode which accounts for the development of the situation of interest through time. As an example let us imagine a reference mode (Figure 2) for the model of Figure 1 regarding "Revenue" as the variable of interest.

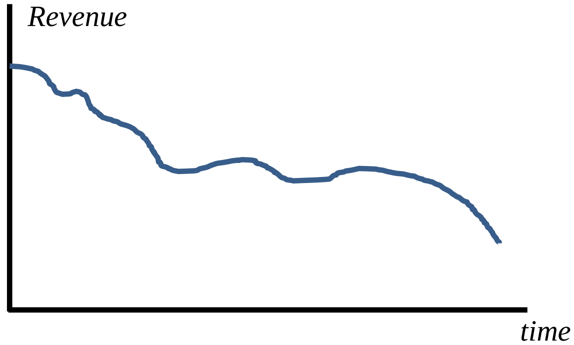

Figure 2. A reference mode for Revenue.

Once we have the reference mode, how to proceed? Randers suggests that "having specified the reference mode, the modeler should identify the fundamental real-world *mechanisms* assumed to produce the reference mode. He should select and describe the smallest set of feedback loops considered sufficient to generate the reference mode" (p. 131, emphasis added). Although this heuristic is important since it orients the modeling process to a feedback-based conceptualization, there are no further guidelines for identifying such "mechanisms". How to identify them? Randers does not provide hints or possible guiding questions. Regarding the next stage (model formulation), Randers suggests to identify first the system stocks: "the levels describe a set of independent variables, together sufficient to describe the state of the system" (p. 134). Next, the modeler should identify the causal influences on the rates that affect the stocks, keeping in mind that "these causal influences should embrace the basic mechanisms that the model is supposed to include" (p. 134). Afterwards, "the modeler should choose numerical values for table functions and time constants" (p. 134), which allows to continue with the following stages: model testing and implementation.

We want to stress that up to this point there have been no mention of actors or decisions. Indeed the guidelines of Randers do not mention the possibility of considering actors or decisions for conceptualizing a system. Instead, he refers to *variables*: stocks, flows and time constants. But already the modeler may have a running model, whose conceptualizations rests on feedback mechanisms, stocks, flows and parameters that do not warrant the modeling of interactions and variables that reflect decision making. Such an approach that overlooks actors and decision through the modeling process is fairly common in most guidelines and proposed methods.

The guidelines of Sterman (2000) are perhaps the ones that make the strongest emphasis on *action-oriented* considerations for changing a social system. He emphasizes the orientation of the modeling process to solve a problem ("not only to gain insight", p. 83), that is, he underlines the interest in devising *actions* for improving the performance of a system, "…taking action in the real world… The purpose is to help the clients solve their problem" (p. 85). He also underlines that the modeling process is iterative although also clarifies that there is no cookbook recipe, there is "no procedure you can follow to guarantee a useful model" (p. 87). Nevertheless, he identifies 5 activities (problem articulation, dynamic hypothesis, formulation, testing, policy formulation and evaluation) that "all successful modelers follow… [and that take place] in context with the ongoing activities of the people in the system" (p. 87)—see Figure 3. Such a context gives a learning and action-oriented direction to the modeling process:

> Strategies, structures and decision rules used in the real world can be represented and tested in the virtual world of the model. The experiments and tests conducted in the model feed back to alter our mental models and lead to the design of new strategies, new structures, and new decision rules. These new policies are then implemented in the real world, and feedback about their effects leads to new insights and further improvements in both our formal and mental models. Modeling is not a one-shot activity that yields The Answer, but an ongoing process of continual cycling between the virtual world of the model and the real world of action (p. 88).

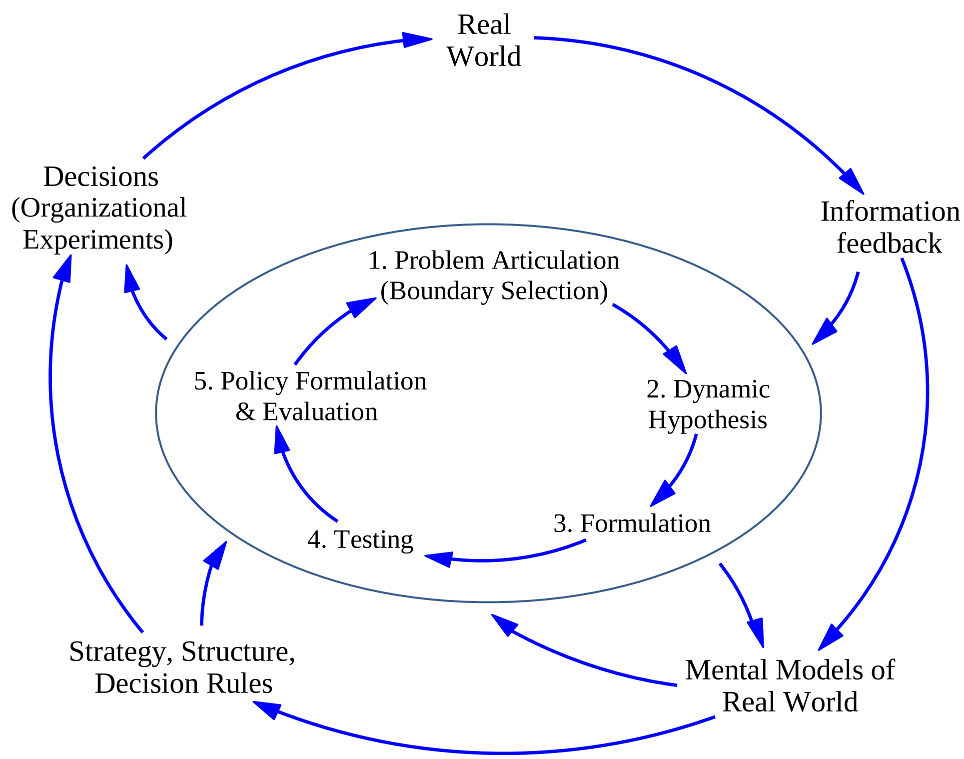

Figure 3. Sterman's placement of the iterative modeling process in the action-context of the modeled social system (Sterman 2000)

After clarifying the problem and the purpose of the model (problem articulation, reference modes, time horizon), the guidelines of Sterman suggest as a second step to formulate a dynamic hypothesis, which corresponds to the conceptualization of the system to be modeled. He recommends exploring the current theories about the problematic behavior as a first source for generating an initial hypothesis keeping in mind an endogenous view based on feedback structures as the explanation of the problematic dynamics. For mapping an initial model the advice is to use diverse tools and data including "key variables". Sterman is explicit on the relevance of decision rules as central components: "An endogenous theory generates the dynamics of a system through the interaction of the variables and agents represented in the model. By specifying how the system is structured and the rules of interaction (the decision rules in the system), you can explore the patterns of behavior created by those rules and that structure and explore how the behavior might change if you alter the structure and rules" (p. 95). This is perhaps the most explicit modeling guide regarding the relevance that the identification and formulation of decision rules has on the modeling process. And yet, it still does not point at explicitly addressing the actors of the modeled system for helping to deliver those decision rules in the model. However, Sterman indeed stresses a decision-rules orientation and hence does suggest corresponding diverse mapping tools for conceptualizing the dynamic hypothesis. From his suggestions we will highlight what are called "policy structure diagrams".

Policy structure diagrams were proposed by Morecroft (1982) who noticed that although causal loop diagrams are useful for policy analysis and for representing the feedback structure of a system, they are weak tools for conceptualizing a system for various reasons: there is little correspondence between mental models (more oriented to component parts) and loop structure; there is also the widely recognized limitation that causal loop diagrams do not distinguish explicitly physical flows and accumulations as distinct from information structures; and especially for our goals here, according to him causal loop diagrams do not explicitly represent decision-making processes. Morecroft is particularly explicit regarding this limitation:

> It is not possible to look at a causal loop diagram and deduce where decision are being made, how responsibilities are distributed, and what information different decision makers deem important in their part of the system. By ignoring the existence of decision-making processes, causal loop diagrams overlook real features of organizations that can lend precision to the generation of system linkages. Decision making processes, or policies, are nodes of the information network. They are the points in the organization. They are the points in the organization that information is collected, processed, and dispersed. Recognizing their role as information processor, we can be discriminating about the quantity and content of information that is likely to be used at any policy point. The causal loop diagram fails to make use of decision-making features of the real system that are valuable in conceptualization (p. 22).

The model in Figure 1 shows these limitations indicated by Morecroft. Because of these shortcomings, he introduces two tools for conceptualization that allow to portray the structure of a system in terms of "real decision-making processes and in organizational units that are compatible with mental models" (p. 23): the subsystem diagram and the policy structure diagram. The latter one is of particular interest here: it is intended to show a simplified structure of the information network "in terms of major policies, or decision functions such as inventory, control, pricing, or manpower planning" (p. 24) and the information network that support those policies without excessive detail. Morecroft suggests two steps for constructing these policy structure diagrams:

1. Drawing policy symbols to delineate decision-making responsibilities. He underlines that this step is crucial and does not occur in causal-loop diagraming since the latter is based on intuition and brainstorming without a systematic discipline. Instead, policy structure diagrams lead to recognize explicitly decision making points.
2. Building the information network using policies as nodes for information links. These links generate a network of communications and they can be identified by considering, for each policy point, this type of questions (p. 24):
    - What information is available at a particular point of decision making in the system?
    - What information would be relevant to the decision-making processes in question?
    - With which parts of the overall system is the area containing this policy in closest communication?
    - What information is not available at this point in the system, and why not?
    - How much information is entering the policy, and is it possible to collect and meaningfully process such information?
    - What is the quality of information available at this point in the system, and what distortions are likely to arise?

Following these steps Morecroft underlines that a "feedback structure is then created from the orderly process of piecing together multiple decision functions, rather than emerging from the more tenuous and ad hoc methods of postulating causal links independent of the underlying decision-making process" (p. 24).

The emphases of Sterman and Morecroft on decision-making are important for addressing social systems and goes in line with our paper. How to identify decision-making points? How to cover all possible actions and decision that may be relevant for a particular problem? Is it possible to have a systematic procedure that helps modelers to conceptualize the social system so that pertinent decision processes are included in the model? There could be an additional step in the conceptualization process that may help to answer these questions and advance and complement the proposals of Sterman and Morecroft: actor analysis. The next section delineates a heuristic for integrating a systematic analysis of actors for guiding the conceptualization stage that acknowledges decision-making as the central feature of action for improving social systems.

3. Identifying Actions and Actors for Conceptualizing Social Systems

Here we introduce a practical tool that has been useful for us when guiding the conceptualization stages in SD modeling based on analyzing actors and their actions in the social system that produces the problem to be modeled.

As system dynamicists know, the importance of having a clear problem and a clear modeling purpose is to have boundary criteria. This is not trivial and we have to be explicit in recognizing that a problematic situation has different perspectives and angles (there are already good options for dealing with this matter from a SD perspective, e.g. (Lane & Oliva, 1998). This is why the first stages of modeling that deal with problem identification and setting a purpose are recognized as crucial for having successful results (Martinez-Moyano & Richardson, 2013). Assuming that the first stages of problem identification and model purpose have been addressed (at least on a first initial iteration) then we can recognize that there is a social system "producing" that problem and the goal is to build a model or various models that capture the dynamics in which such system indeed "produces" the problem. That social system to be modeled is not necessarily easy to identify. It does not have to match the organization in which the problem develops, it does not have to correspond to a clearly identifiable organizational unit, etc. Indeed we should be aware that we will model a problem, not a system as such (Sterman, 2000). More precisely, *our goal is to model the social system that produces the problem*. That system is indeed a "process": it has a temporal dimension and a temporal unity, exists through time, it is a bundle of *activities*, see e.g.(Leclerc, 1953; Seibt, 2013). That process-system is created, contingently many times, through the actions of diverse actors, perhaps from different organizations or social groups, from different subsystems, etc. that end up together, often non-intentionally, producing together the problem through their decisions. These problem-generating social systems are formed *in action*, rarely they will match a formal, recognizable object-system. For each problem there is a distinct, dynamic, emergent social system "producing" it. Two different problems that seemingly take place in the same organization will have certainly two different systems producing them. The heuristic that we introduce helps to identify such dynamic systems; hence, these guidelines can be particularly helpful when the modeler faces a messy problem to which is not easy to associate a single, concrete, formal social system (e.g. think of public problems, region/country level problems, etc.). We will conceptualize the system by examining actors, actions and inter-actions (system structure) that end up generating the problem to be tackled.

3.1. Identification of Roles and Actors

We are interested in a particular social system: the one that dynamically produces a problem. Who is an *actor* in a social system? This is not necessarily an easy question to answer. The classic definition of "stakeholder" of Freeman (2010) seems a good starting place given its impact and the development that has taken place on stakeholder theory; a stakeholder is “any group or individual who can affect, or is affected by, the achievement of a corporation’s purpose. Stakeholders include employees, customers, suppliers, stockholders, banks, environmentalists, government and other groups who can help or hurt the corporation” (p. vi). That definition is intended to inform corporate management and defines the stakeholders *of the firm*. However, we are interested in the stakeholders *of a problem* (our modeling boundary criterion). Since we are interested in the way in which actually a social system produces such a problem, we are concerned with *agency* and *actors* and will prefer this latter term over “stakeholder”. The term “actor” denotes an agent “who act”—from Latin *actor* "an agent or doer" (Harper, 2016)—in this case as related to the problem. Not necessarily everyone that has a stake in something, does something about it. We can thus rephrase the definition of stakeholder and define an actor as:

Any group or individual who can affect, or is affected by, the problem to be modeled.

This definition supposes that an actor affects the problem through his own actions. An actor takes resources and information and take actions that impact the social system in which s/he participates. The definition also supposes that those affected by the problem re-act and do something about it. Notice that an actor can play one or more different *roles* in a problem (e.g. a company can be a *competitor* for firm A but a *partner* for firm B.). Such roles then are defined by what the actor does and by the perspective from which that action is assessed. From this point, there are several possibilities for attempting a systematic classification of actors. Espejo and Reyes (2011) propose a methodology for diagnosing systems that is useful for us. We adapted it to identify different types of roles that can be played by diverse actors (as related to the problem):

- *Drivers:* those that “drive” the problem; their actions have a *direct* impact on the problem. Given defined measurements or variables for the problem (e.g. reference modes), which actions can be identified whose *outputs* impact directly those variables? Who are the agents that execute those actions? These can be difficult questions to answer, especially if the reference modes are abstract and aggregated (Saeed, 1992).
- *Suppliers*: those providing resources and relevant information for the actions of the drivers.
- *Affected:* those who are directly affected by the problem and that can take action for counteracting it.
- *Owners:* those who have an overview of the problem and have the responsibility to solve it. (Indeed the “owners” of the problem). They can take action in different ways.
- *Interveners:* those that belong to the context or the environment but that can provide *at any time* opportunities or threats for improving or worsening the situation to be solved. These can be regulators, partners, competitors or collaborators of any other actor. Such opportunities or threats can be actualized through direct action or by providing resources or information to other actors.

Thus, a first step is to identify the actors (individuals, groups of persons, organizational units, whole organizations, groups of organizations, etc.) that play the previous roles. Naturally, as it was mentioned, within a modeling process these steps are also iterative. An actor can play simultaneous roles and also a role can be played by a group of actors; they can be mapped in a table for instance (See Table 2).

Roles	**Actors**
Drivers	- - ...
Suppliers	- - ...
Affected	- - ...
Owners	- - ...
Interveners	- - ...

Table 2. Mapping actors according to the roles they play.

There are different options for completing the table (and the next one that follows), many of them related to qualitative modeling, e.g. workshops, brainstorming sessions, scripts, focal groups, etc. Methods from Group Model Building and Community-Based System Dynamics can be particularly helpful (Andersen & Richardson, 1997; Hovmand, 2014; Vennix, 1999; Vennix, 1996).

3.2. Interests and goals

The next step is to establish the interests and goals of the identified actors as related to the problem. "Interest" refers to concern or attention that an actor has on the problem to the point that he is willing to act to satisfy those interests. A "goal" is a concrete aspiration toward which an actor is willing to act in order to achieve it (either concrete targets or informal and abstract ambitions). This step is helpful also for the later formulation of decision rules since it helps to identify motivations and the reasoning behind actions for each actor. Possible gaps between desired states and current states can be later formulated, etc. Various questions can guide the identification of interests and goals for each actor:

- *Drivers:* Which interests does the actor have that prompt him/it to “drive the problem”? Which goals does he/it pursue?
- *Suppliers*: Why does the actor supply specific resources or information? What is the purpose for doing it? Which goals does he seek to accomplish by providing those resources or information?
- *Affected:* Which interests (of those actors that are affected) are impacted by the problem? Which goals are affected by the problem?
- *Owners:* What are the goals that an owner would want to achieve by solving the problem? Why is s/he interested in solving it?
- *Interveners:* What interests may the intervener have on the problem? Which goals could he attain by improving or worsening the situation?

Table 3 includes interests and goals in the actors and roles schema.

Roles	**Actors**	**Interests and goals**
Drivers	Actor 1	- - ...
	Actor 2	- - ...
	...	
Suppliers		
Affected		
Owners		
Interveners		

Table 3. Identifying interests and goals.

3.3. Actions

Actors seek to defend their interests and to attain goals. They take action though diverse decision-making processes. The objective of this step is to map the relevant decision processes (as related to the problem) attached to those interest and goals. These decisions can be mapped identifying inputs and outputs for such actions. Both inputs and outputs can be tangible (e.g. people, things, physical resources, raw material, widgets, etc.) or intangible as e.g. information about something. Naturally there can be more than one action associated to a particular interest or goal. Figure 4 shows a way to map actions in terms of one or more inputs to produce the output of the action.

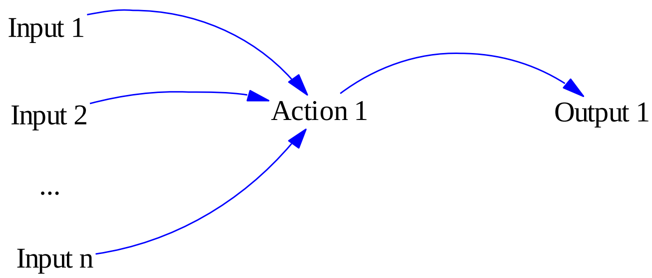

Figure 4. Actions take one or more inputs and produce an output

At this point we find particularly useful the “policy structure diagrams” of Morecroft previously mentioned and can be used as a tool for mapping the identified actions. Notice also that as we mentioned before, an action oriented model brings a dynamic view of a problem since actions occur through time as part of cycles of *action* → *world* → *information* → *reaction*. (Figure 5).

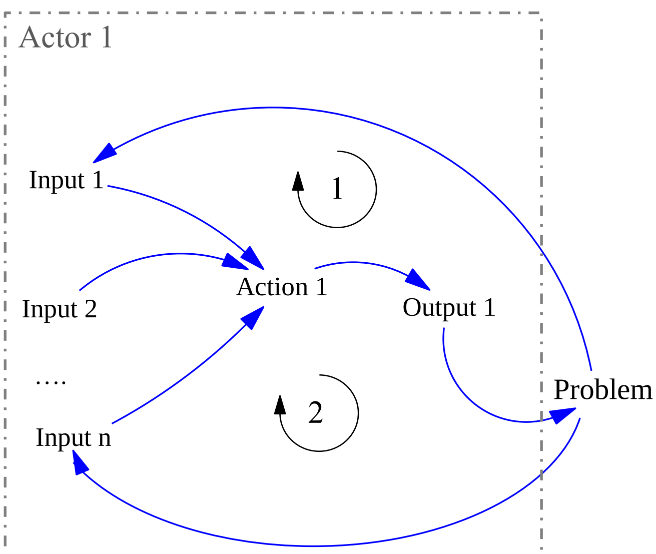

Figure 5. Actions entail a dynamic view of an actor

3.4. Feedback, model and formulation.

A conceptualization process based on actions and decisions warrants a feedback view since actors take information from the world and use it to produce actions that seek to change it. With all the actions mapped then feedback loops can be identified since all actors either act on the problem and/or are affected by it. In addition, several actors form subnets of information and resources exchange—see Figure 5. This is a benefit of this heuristic given that it can be hard to conceptualize or elicit feedback structures, especially among novices and in group model building processes (Andersen & Richardson, 1997; Vennix, 1999). These guidelines provide a systematic way to arrive to diverse possibilities of feedback loops that can inform the modeling process. An iterative and fruitful process of filtering and discussing the relevant feedback mechanisms should arrive to a first agreed set of feedback loops that are candidates for explaining the problem that the social system produces. Further iterations within the larger modeling process (Table 1) should refine that set.

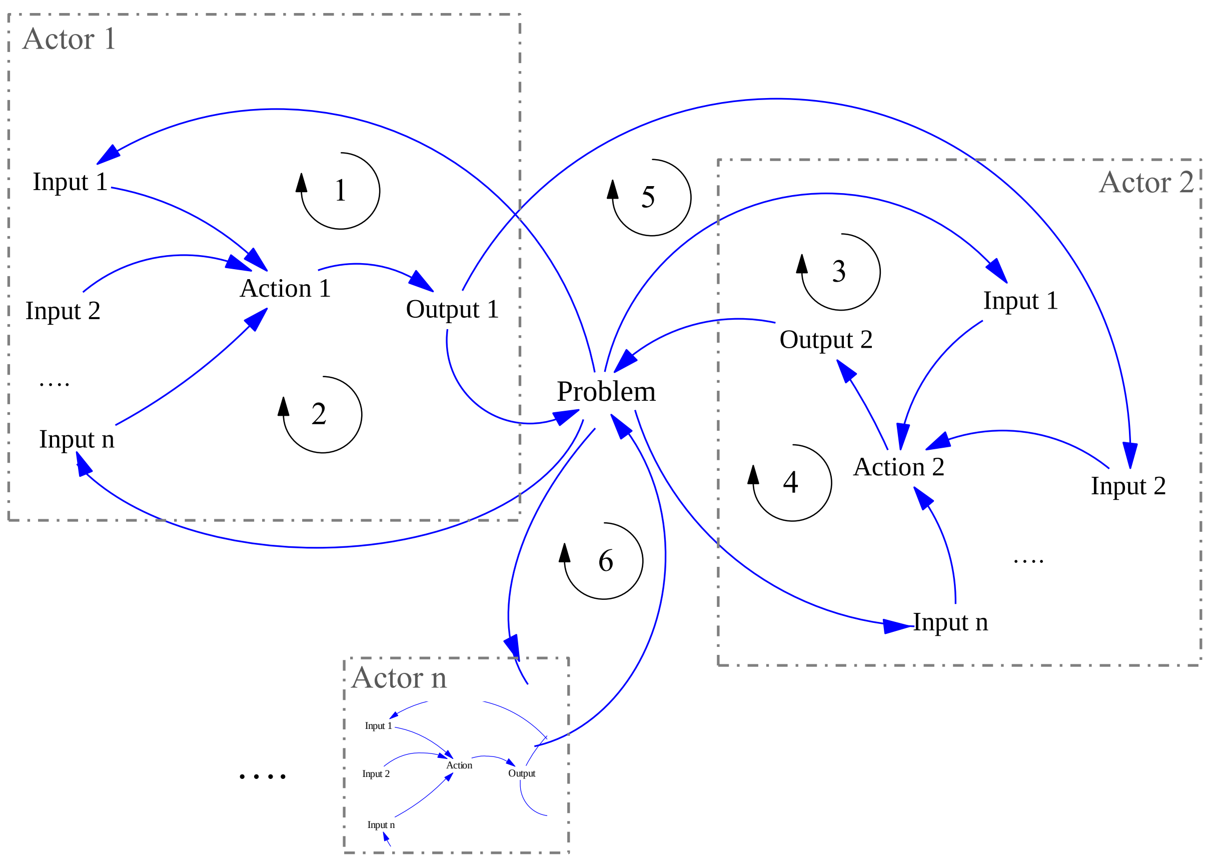

Figure 5. Feedback structures created *in action* in a social system

From this point the modelers can retake the question addressed by Randers (mentioned earlier) and others: which feedback loops can be particularly relevant for the problem? And the modeling process can go to the next stages, either building a causal loop diagram, a stock-and-flow diagram etc. and proceeding to formulate a first version of a simulating model if appropriate. Diverse possibilities for formulating the decision rules are available depending on further field work or modeling assumptions regarding the rationality and the way in which the involved actors are assumed to decide, see e.g. (Größler et al., 2004; Sterman, 2000; Sterman, 1988). In a future work we will develop a full applied example.

4. Outlook

We introduced a methodological guideline for the conceptualization stage in model building of social systems. The identification of actors provides a script that helps to conceptualize a first model that warrants it to be anchored on the networks of actions and decisions that actors take and that end up *producing* the problem for which the model is built.

The identification of actors serves as a heuristic for demarcating model boundary in terms of those. Which actors drive, influence or are affected by the problem? The heuristic can be also extended for policy analysis and design within a modeling process (Table 1). New actions, new actors, new roles can be conceived which may mean to change or create new feedback loops. Which actions should this or that actor take? How? Who has the power to transform the system? Who can play new roles? Which actors should be included? Who should be the suppliers? Who should be the owners? Who should be the interveners? Why? This approach helps to identify normative implications for an ethical modeling practice (Ulrich, 1987). Moreover, there can be stakeholders that are unable to act on the problem (that is, affected stakeholders that do not have the possibility of doing something about it). The inclusion of those groups as possible new *actors* opens the doors for modifying boundaries and creating new systems.

As a final word, we do not present a “recipe”. It is just a heuristic. It can be helpful for some modelers for some problems and not for others. It can be helpful in particular situations and not in others. We believe that it can be particularly useful for novice modelers that face the challenge of conceptualizing systems though modeling. It can be also helpful as the base for group model building scripts (Andersen & Richardson, 1997). The presented schema serves as an organizing device for thinking in terms of actors and in this way helps to avoid the risk that Ackoff warned about when attempting to build a model of a social system: we may end up modeling it, unknowingly, as a determinist system by ignoring that it is formed by actors who act and that through their actions indeed generate what the system does. Our heuristic is intended to improve the mental models of modelers (and parties involved in a modeling process) by making them to consider *actions* and *actors* as prominent over *causes* and *variables*, the latter being more abstract and not necessarily connected with agency.

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