Managing improvement amongst autonomous actors with OMCA: the case of the Chilean Educational Reform

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ABSTRACT:

This paper proposes a methodology for action-learning that is currently under configuration. It is based on a model of the human actor that is inspired by biological and linguistical investigations. This model describes how organism and observer co-develop and shows how and why acting and explaining interact and how different levels of coherence can be obtained.

The necessary discipline in acting and explaining is proposed in form of the OMCA approach, which organizes cycles of observing, modeling, constructing and acting. Inside this methodology, one specific method is developed, drawing from congitive mapping, systems dynamics simulations and information systems development techniques. The method is currently used in a project of the chilean ministry of education, from which the examples or this papers are taken.

This first experience suggests that following OMCA hels producing validable knowledge and improved action, allowing for parallel search amongst autonomous actors.

1 Introduction

This work is rooted in the observation that the chilean educational reform is a “wicked mess”: there is a multitude of autonomous actors intervening in its evolution, and education as a “production” is a complex process wich allows for divergent points of view and policies, and also one with many interrelated sources of influence. ENLACES as part of the reform introduces computer networks into the schools, trying to foster innovations and support autonomy. In it, there are three levels of autonomous actors, defining different aspects of the relevant “world”.

In this type of context, OMCA (observing - modeling - constructing - acting -) as a scientifically oriented action-learning approach can help expliciting and improving otherwise tacit choices in the actor’s policies. We have used it to draw up a conceptualization of this world and configure action in one of the actors, seeking to attract the other levels, and the effect of OMCA on the models and consequences of action are visible.

This paper introduces a model of the human actor that fundaments our iniciative, in section 2. In section 3, OMCA is introduced, in methodological terms and with a specific method. Section 4 illustrates its use in a selected subdomain of ENLACES.

2 Action and Explanation as Human Forms of Knowledge

During the history of thought about human affairs, many images of the human being have been proposed. Most of them had philosophic reflection and direct observation as fundament. Nowadays, advances in our scientific knowledge about our biology allow us to propose a model grounded on a scientific base. This has the advantage of making the why? of our model of the human actor critiquable, and with it our approach. The biological explanations in this section draw mainly on Maturana's work (1997), and coincide with views held by evolutionary psychologists (Barkow et al., 1992). The explanatins about coherence are inspired by the work on decicion-aid of Roy (1985).

2.1 A model of the human actor

Just like any mammal, we have an organism that consists of a nervous system on one hand and muscles, other organs, bones and so on on the other hand. Each of these complexes is an operationally closed system: in each moment of their existence, they find themselves in a specific structural arrangement that defines the possible transitions towards other structural arrangements.

Thus each of the two systems is self-referring and closed. However, they intersect in the sensors and effectors. Our muscles move (we act) when they are triggered by nervous impulses; also, any muscle movement triggers new nervous impulses. Additionally, many of the cascades of transition in the nervous system do not terminate in effectors (they stay internal to the brain).

Thus it becomes possible that, as part of its self-centered transition cascades, the nervous system correlates stimuli in the sensors with responses in the effectors. As our sensors are in-formed by a change in their medium, they push a cascade of inner transitions along one possible way of inner changes. The organism progressively perceives or constructs an image out of the multiple impulses sensed, by discrimination and classification. Thus the organism distinguishes between groups of conditions or changes in its medium. As we follow the cascade of transitions, we may finish in effectors that make the organism move as a whole, together with its medium. An observer of the whole organism will call this behavior or action.

All the way down the cascade, many decisions have been taken, and at each point new cascades may have been triggered. Each of these may result in qualitative structural transitions (one of the possible ones inside the former structural configuration) that we will observe as learning. Additionally, the changed medium (in which there may be other organisms) will terminate triggering sensors of our organism anew. Life is a continuous cascade of such transitions, and in each moment, the structural configuration means a particular predisposition (decision flow), that we usually call emotion.

Up to here, all learning takes place automatically, without conscious effort, in fact even without awareness. Much of our learning works like this, and as long as we live, we cannot avoid it. But there is more to it:

When there are several such organisms in the reach of one another, repetitive interactions can trigger streams of learing that result in coordinated behavior. The interactions that coordinate action are called language. In the case of human organisms, the particular organization of the brain makes it possible to go even further. We create objects in language -chunks of inner configurations and movements that stand for patterns of action we share with other humans- and then treat them as if they were external objects. In a way, we cannot avoid doing so, since the nervous system does not inform itself back about these changes as in the case of muscle movements (this is the lack of proprioception that David Bohm worked about). We can thus coordinate our coordination of action in language.

In the sphere of language arise awareness and the self (Maturana), and it is there where we exist as observers of the world and makers of experiences. We generate observations (objects in language) that refer to distinctions in the organism, and again we cannot avoid doing so: we cannot not explain to ourselves the experiences we make, and by default we do this without becoming aware of it.

As with any action, what we observe as experience and how we explain it refers to something that has realized itself without our observation and explanation. However, observing and explaining are actions that will trigger particular cascades of transitions according to how we observe and how we explain (Maturana).

Explanations are recursive, that is, we can explain explanations. Thus an explanation *B* can tell us why an explanation *A* may be valid, and then explanation *A* can refer to explanation *B* to obtain validity.

This model of the human actor is resumed in the following figure:

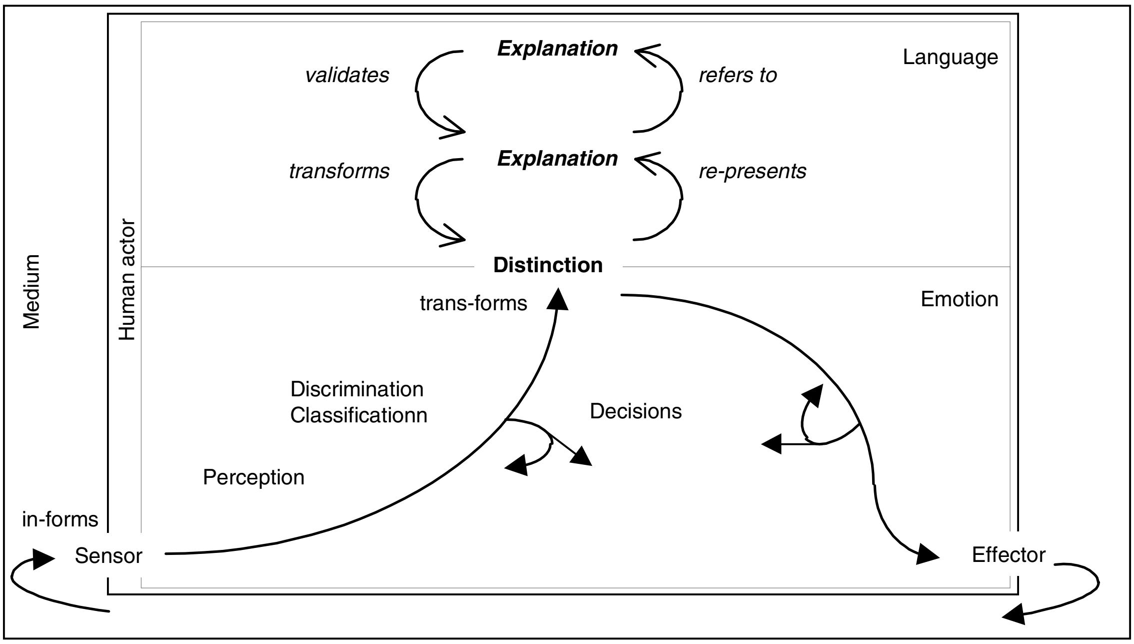


Fig. 1: the model of the human actor

The following statements resume essential features of the model:

Action	*Explanations*
changes the medium	are images of the distinctions that can now be explained
changes distinctions	can in themselves be explained
does not require explanations	can change distinctions
	may under specific circumstances change action

1.2 Coherences

Why should explanations deserve our attention? The answer is that if we wish to escape from competence traps and other courses of superstitious learning, and if we wish to escape from problems that stem from the abyss between tacit knowing and explicit knowledge (Polanyi, 1983), then disciplined explaining may be the only way out towards "theories-in-use" (Argyris, 1993).

To see how explaning may do this, let us begin by stating that the explanation and what it refers to are two seperate things. We can invent any explanation we wish or we happen to. We can use it to justify the past (Maturana and Varela, 1984, p. 154), or to design the future. Also, each actor creates his own distinctions (tacit knowing) and explanations (explecit knowledge), and so there are as many complexes of knowledge as there are actors, even if they are coordinated by language. Some explanations may conduce to successful action, and others may not; the only way to find out for sure is to try them out. However, all we have to check validity is explanations, which are built on observations (experiences). No one has direct access to what we like to call „external reality“.

Obviously, we wish to explain in a way that sorts out explanations that would lead into anticipable problems. We distinguish four levels of coherence, two of wich can indeed be obtained without trying them out.

Once we have a set of explanations (a model), we can try to find inner contradictions, for example by simulations. If we confront the model to its own consequences, does it resist? When we have sorted out these problems, we have explanations in *inner coherence*. We can also check against other, currently accepted explanations (as suggested by Popper, 1990), however there is a conceptual problem: in a world where no explainer acceeds to the one, exclusive, „real reality", the „truth“ of one model does not imply the „falseness“ of a different model.

We can then go on to see if our (simulated) model reproduces historical experiences (this is suggested in Senge et al., 1995; it also is one of the conditions for considering explanations as valid according to Maturana). Once our explanations do so, we can call them *historically coherent*.

And this is all we can do *before* acting. If we act according to our explanations, we will become informed about the consequences, and compare them to those we would have expected following our explanations. If we take care to specify what we expect to observe, and how we could observe also what we did not expect, then the information about our action‘s consequences will reveal our model‘s *explanatory coherence*. This is not the same as the historical one, since the experience we had to compare our model‘s behavior to was based on older –often even tacit- models, and did probably not come from disciplined observing.

Beyond this comes *operational coherence*, which refers to the cascades of transitions resulting from action taken. If they prove to be innocive to the actor, then the corresponding explanations can be said to be operationally coherent. However, this is out of the reach of explanations, that only *refer to* what happens outside the sphere of language. (To illustrate this, think of a smoker who keeps smoking with a happy set of explanatory coherent ideas, that seem to confirm his action until the day he falls sick.)

Resuming, *disciplined explaining* is what we do to obtain a set of explanations that is internally, histortically and explanatorily coherent. This means that we need explanations in order to act and learn (as said above), *and* we need action to explain and learn: acting, explaining and learning have to become united. This is what OMCA is about.

3 OMCA: Observe – Model – Construct - Act

3.1 Linking Action and Explanation in Four Steps

Observing, modeling, constructing and acting are four types of action that, combined in iterative loops form the OMCA approach. We propose this generic process as means for joining action, explaining and learning in persons and in organizations, since it enables single-loop and double-loop learning. Here, we give a brief definition of each of these actions:

Observe

- Function: create raw explanations that refer to distinctions of the organism

- Function: to learn to observe
- Attention: what is not observed cannot be designed
- Observing the observing is useful

Model

- Function: to generate internally and historically coherent explanations
- Function: to learn to model
- Causal mapping and systems dynamics simulation are useful
- For each explanation we have to explain its operational aspects, its relationships with other explanations, and our possibilities to observe it in action
- Take into account implementation issues, in order to be able to distinguish them from “theory” problems
- There has to be an explicit process of using the observations in order to improve the explanations and correct "errors"
- what has not been modeled, shall not be constructed

Construct

- Function: to generate artifacts that allow to act out and test the models
- Function: to learn to construct

Act (and Observe)

- Function: to intervene in target-systems such as to obtain desired states
- Function: to obtain observations
- Function: to learn to act with a higher degree of awareness

OMCA is anchored to our model of the human actor:

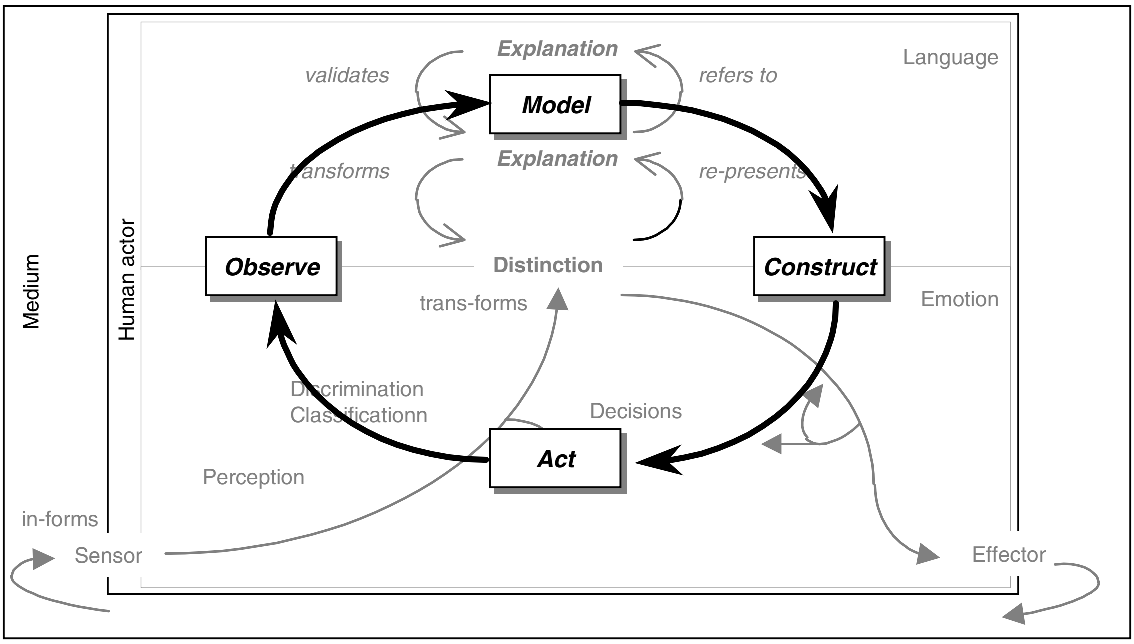


Fig. 2: OMCA and the model of the human actor

3.2 An OMCA method for shaping management and information systems

Since the above formulation is general, it may be used in various contexts. We use it as a possibility to configure and specify management systems together with the corresponding information systems. (To be accurate, a management system is not the system it manages; however, we cannot exclude the management system itself from our modeling without losing the possibility to manage the management system.)

The following method embodies this intention. It divides modeling into three steps; in the first of them, it borrows from cognitive mapping (Rodhain, 1997) and definines a set of concepts and links that serve for creating an image of a part of the world in wich we wish to manage. Then the map is translated into simulations that leave us with defined policies in the management system. In the third step, a specification for an information system will be derived from the models. The following figure shows this schematically, before presenting each of the steps in turn:

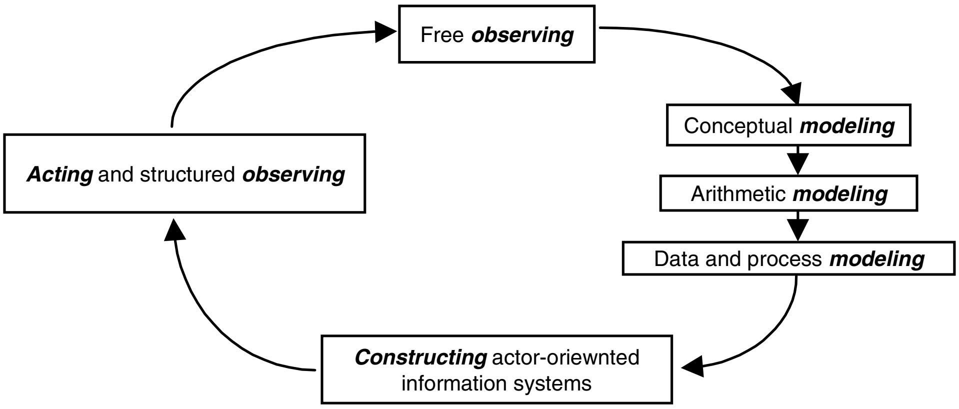


Fig. 3: a specific OMCA method

3.2.1 Observe

The starting point of our work will be a joint inquiry into the *Objectives* we see in the system under study. Any technique to do this may be used, but we call attention onto *dialogue* and related approaches to suspending tacit knowledge (Bohm, 1996), and *listening* as worked out by Winograd and Flores (1989).

3.2.2 Conceptual modeling

Now we will build the first “real” model, and for this part we use a particular notation we have defined, using the "Descision Explorer" software coming from the field of congitive mapping (Rodhain, 1997):

Symbol	*Meaning*	*Explanation*
Unit	*Unit*: a „thing“ than can be observed o experienced; takes the form of a dimension or attribute. In each moment, finds itself in one of its possible states; can transit between states; if a range or tendency of states is specified, the *Unit* is an *Objective*.	Our *objectives* describe desired states of something in the world; we have to say what to pay attention to, in order to see ho we achieve them (or not). Also, we shall connect our models (theories) to observable parts of the world in order to discover their explanatory coherence. Later on, *Units* will turn into types of entities and types of attributes in datamodels.
Actor	*Actor*: a person, a group or a role that controls a domain of *activity*. This symbol stands for the *idea* of an *actor*; any concrete element is a *Unit*.	Things happen because *actors* do them; each *actor* has his wishes and particularities, and thus our configuration process will take into acount the *actors* who influence any of the *Units* we are interested in.

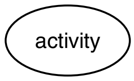
	*activity*: a process that triggers changes and transitions in one or various *Units*; will be broken down into cycles of observe, model, construct and act.	An *activity* is a domain in which an *actor* configures a policy. Inside, he is free to design what he choses to do, but also responsible for the validity of explanations he uses to refer to his policy.

Table 1: types of concepts

Note that the software objects representing the concepts allow for descriptive text to be added; this way, many details about *Units*, say, can be hidden from the diagram without being omitted. Several types of relationship connect these types of concept:

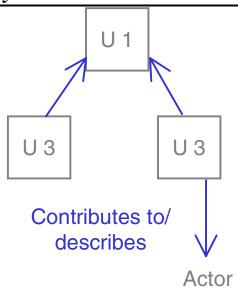
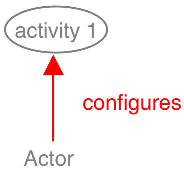
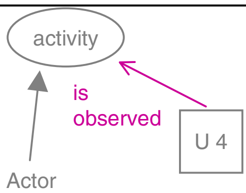
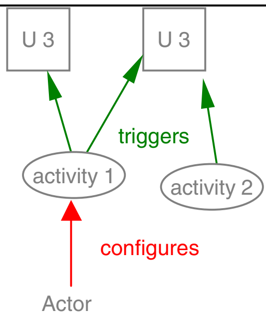
Symbol	*Meaning*	*Explanation*
	One or more *Units* can *contribute* to the constitution of another *Unit*. Typically, *Objectives* will be cosntructed as hierarchies. Also, the same type of relationship *describes*; for example, a *Unit* can describe an *Actor*.	The *contributes/describes* relationship allows to manage a system of objectives over various levels of generality/concreteness. Additionally, we can thus represent „natural“ influences that are not configured by any *actor*.
	Each and every *activity* is *configured* by one *Actor*.	Each time that an *Actor* has the possibility to influence the evolution of a *Unit*, he cannot escape the neccessity to chose (even not doint something is a choice). The way to take this liberty/obligation reveals his theories.
	Usually, *Actors observe* one or more *Units/Objectives* when *configuring* an *activity*.	This enables basic forms of feedback from a *Unit/Objective*, and OMCA could not possibly work without it. This is the seed for information flow models later on in modeling.
	One or more *activities trigger* changes in one or more *Units/Objectives*. This can occur with or without intention.	Side effects and other interrelations between *activities* can be taken into account by approaching activities from a global, systemic starting point. When several *activities* trigger the same *Unit/Objective*, it may be hard to discriminate between what causes which change.

Table 2: types of relationships

With these symbols, we can express a system. But since we are also interested in learning and change, we will produce a cascade of models over time. For changing our mind from one model to the following, other ideas have played a role; so we have a special place for expressing them, too.

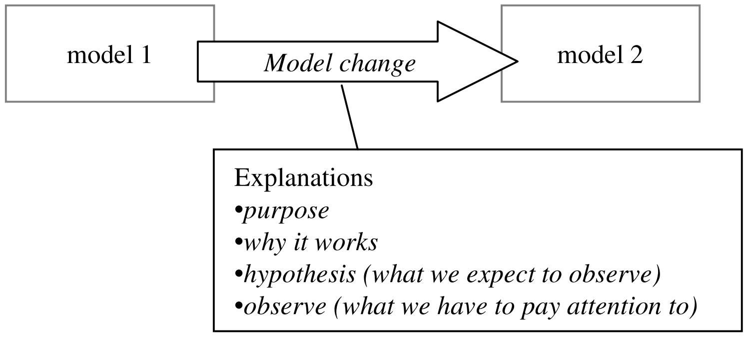


Fig. 4: concepts that explain a change of model

These explanations may give rise to changes in the collection of *Units*. It may be worth noting that the transition from what we had before starting to the first model is not explained this way.

After having constituted an image of the *Objectives*, we can add *Actors* and *activities*. We can start doing so parting from the former or from the latter. There are a couple of questions that provide orientation:

- is my *activity* based on valid explanations or not?
- how did I obtain this validation (what are the *Units* I observe)?
- how could I obtain it, become able to see what I do not expect or what I know "cannot" exist? (What are the *Units* I might or should observe?)

For each *activity*, we will work out a submodel that establishes the OMCA cycle according to which the policy is configured. However, sometimes more than one *activity* will be included into one submodel, due to interdependencies between *activities* and *Units/Objectives*. Inside each submodel, there are all the *Units/Objectives* that an *actor* observes, or that an *activity* influences. However, *Units* that appear in more than one submodel or that are influenced by more than one *activity*, as well as any *Objectives*, have to apprear in the general model, too, in order to clearly show interdependencies.

Each submodel has to be formulated in opertational terms, explicitly establishing:

- each observed *Unit*,
- how observations are used and new information is created out of them in order to model action (new policies, consequences, decision criterions),
- how they are used in order to improve logic and historic coherence (learning)
- how they are used to obtain information about explanatory coherence (learning).

To be sure, we should not expect our progression to be a linear one!

3.2.3 Arithmetic modeling

Obtaining logical and historic coherence is much easier using the simulation faculty of computers. Keeping in mind that our models shall be usable for professionals who are not simulation specialists (Morecroft and Sterman, 1994), we opt for systems dynamics as implemented by the "iThink" software. The conceptual symbols translate easily into stock-and-flow symbols (and *vice versa*):

- *Units* ↔ resources
- *trigger* relationships ↔ information flows that regulate flows

- *activities* ↔ converters
- *observation* relationships ↔ information flows
- *Actors* are not explicitly shown in stock-and-flow diagrams.

We can now follow the recommendations given in the tecnichal documentation of the software. Probably the elaboration of simulation models will imply the creation of new components (converters and the like); these can be distinguished from the "real" components by a particular color coding. Once the actors whom we work with have converged –for now- to a particular policy, we translate back into our conceptual submodel.

Each particular domain submodel has to consider the possibility that during action, a person may prefer acting "outside the system". It matters that this be supported by our system on all its levels of representation, as long as this exception is duely registrated inside the system.

Once all the submodels have been frozen, the general model is updated.

3.3 Data and Process Modeling

Now the *Units* serve for building the data model (entity and attribute types), and the *activities* allow process modeling. The resulting specification serves two purposes: we can establish rules to be followed by persons in the role of an actor, and we can construct automated artifacts that will support actors.

When going to construct automated support, it is important to take into account the conceptual and interactional design (Winograd, 1996). We pretend that our approach to the configuration of managament systems favors well-designed conceptual models; however, interactional design has to be taken care of explicitly.

The resting steps -construct and act- are not described here in detail; one can construct following one of the established methods, and acting shall be done according to the configured rules and supports.

4 A case of use

4.1 ENLACES

ENLACES is one of the projects in the ministry of education of Chile. It intents to foster pedagogical and administrative innovations and technological autonomy in public primary and secondary schools (for a more detailed introduction, see the appendice). Here, we will present how in one "executing unit" (EU, in charge of training and techincal support), our approach has been used to learn more about the work of the technical support function.

At the outset (beginning of 1998), it was clear that tech support would have to visit each of the EU's attended schools a certain number of times per year, and that it would have to intervene in technical problems that do not concern PC hardware (which is under the vendor's warranty).

In the shown extraction, that reproduces a specific part of the whole model (you can see that there are other *activities* like "learn", "prepare" and "train"), we can see that the *activity* "visit", such as configured by the "tech support", triggers changes in the "coordinator's" "activities" and in the "machines" (of a computer lab). The "coordinator's" "learning" is influenced by these "activities", and this in turn influences their "capabilities" that are important for their *activity* "repare", that also triggers changes in the "machines".

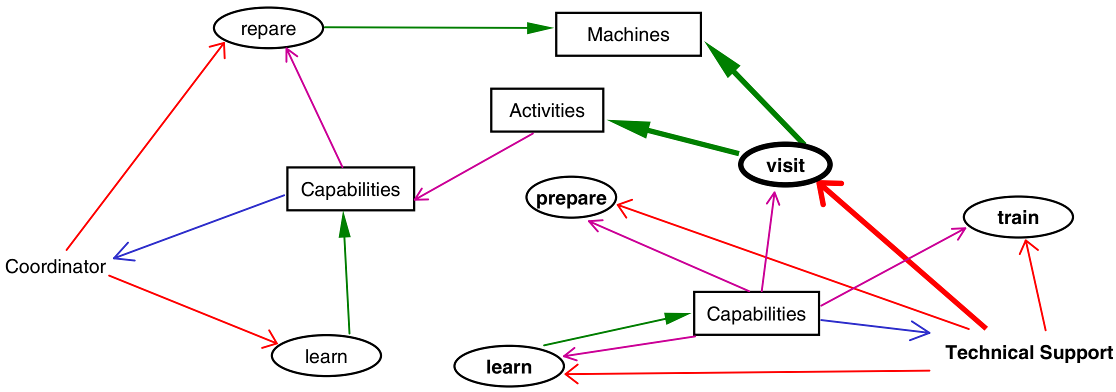


Fig. 5: technical support model 1

During 1998, the EU saw that the majority of interventions had had causes that simple that the question was: "why do they call us instead of just troubleshoot themselves?" The frequent "firefighting" interventions that come with a lot of travelling time have been a constant source of disruptions in the other activities of technical support. On another level, an impression rised as if a lot of problems would be caused more by human and organizational issues that technical ones.

In response to these observations, the question "what is the *raison d'être* of technical support?" was rised, and the final result of the following re-modeling is shown in the following figure:

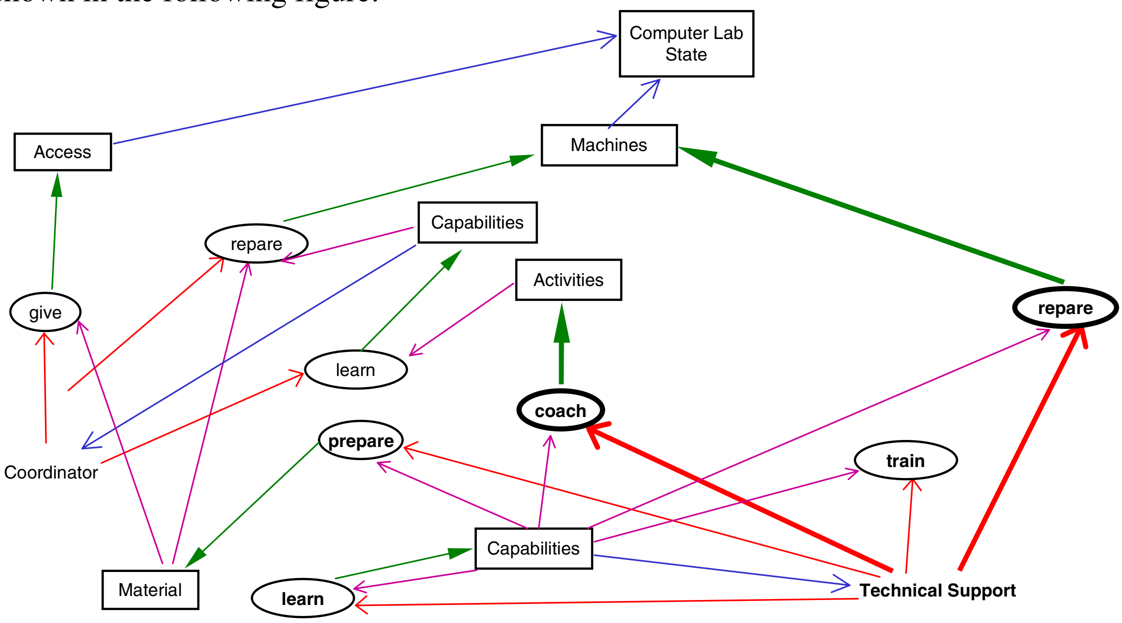


Fig. 6: technical support model 2

We see that there has appeared a superior *objective* (the "Computer Lab State"), which in this extraction is constituted by the "machines" (their state) and the "access" to them. The other change is that the "tech support" *activity* "visit" has gone, and "coach" and "repare" have appeared as seperate *activities*. The change was justified by the following points:

In order to:

- incentivate self-reparation
- stabilyze the planification and realization of jobs

why it will work: if reparation and coaching are separated, then

- obtaining help in form of visit will have a higher cost (of waiting), and so there are stronger incentives for self-reparation
- there will be less time lost for traveling and less re-programming of jobs.

hypothesis: what we should observe as consequences are

- less calls for reparation, and less travelling and "firefighting" time
- fewer changes to the job-programme of a period

observe: *Units* that we should pay attention to are

- *jobs* of "firefighting" type
- *changes* to the *job*-programme
- fewer *actions* of type "travelling"

List-items in italics indicate *Units* that become part of the corresponding submodel:

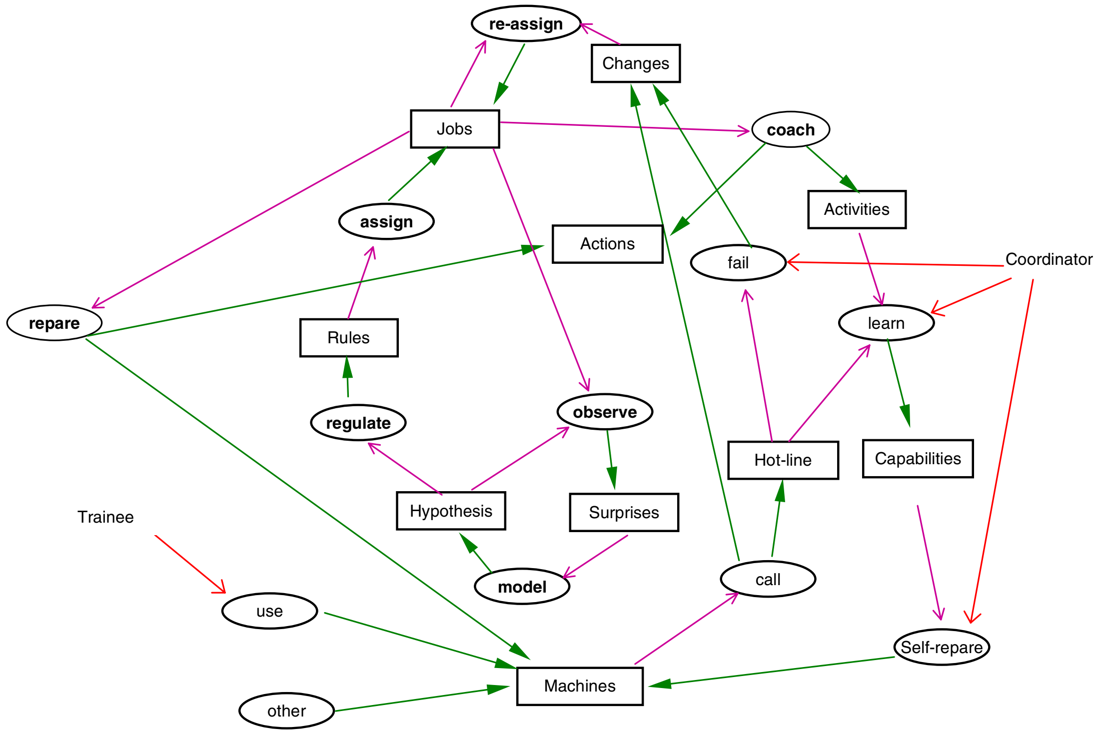


Fig. 7: the submodel for the changed part of the model

In this figure (in which the *actor* "tech support" has not been shown as designer of its *activities* for the sake of lisibility; this is again an extraction of a more complete model about the management of technical support that we have developped with "iThink" simulations), shows some operational details about how the "assigning" *activity* distinguishes between the new types of "jobs", and how the *actions'* consequences are "observed" in order to "model" the "assigning" *activity* anew.

Besides what we have shown here, we are shaping the assignment of resources to the diverse *activities* with the same method; also, there are issues dealing with the configuration of training-courses and the management of trainers. The shaped policies are constructed in form of Java applications that connect to a relational database.

4.2 Current question marks

Each issue at hands demands time to observe, model and construct. Additionally, there are a lot of issues to be treated. During all the time needed, life goes on and the actors have to act. This gives rise to the question: "does everything have to get OMCAed in order to do it right?" A good heuristic to answer this is: whenever there arises a doubt over if a particular issue might be improved, one can use the described OMCA method, one issue at a time. As long as there is a general map that captures interdependencies, each decision opportunity can be trated in isolation.

A second question may be "are ther other OMCA-compliant methods I could use?" Yes, we think that there are: especially "decision aid" (Roy, 1985) can be used in chains of decisions such as to substitute the disciplined construction of alternatives, consequences, dimensions and criteria for the presented modeling methods.

5 Conclusions

In this paper, we have started by presenting our model of the human actor, that establishes the distinction of the spheres of existence: the organism and the observer. According to it, explanations can show various levels of coherence, of which the highest accessible one needs action in order to get informed on its coherence (validity). OMCA has been presented as an approach to combining disciplined acting and explaining in order to improve actions and learn the necessary, congruently with the model.

One particular way to do the modeling part has then been introduced; it intends to shape management systems, comprising the corresponding information systems. In its way to map ideas, this method respects the actors' autonomy and distinguishes between observable states of the world and the processes that influence changes in them. This tool stays sufficiently simple to be read by a no-specialist, allowing simulation-for-learning at the same time.

It is has to be said that this is ongiong work, and thus no strong claims on validity can be made yet. However, we believe it to be a workable approach to introduce organizational learning into the everyday work of everyday people. We also believe that various actors can use OMCA to cultivate their respective policies/models by responsible experimentation-in-action, using the resulting diversity as kind of a parallel search system for viable policies.

6 References

Argyris, 1993	Argyris, C. (1993), Knowledge for Action, Jossey-Bass
Barkow et al., 1992	Barkow, J., Cosmides, L. and Tooby, J. (1992), The Adapted Mind, Oxford University Press
Bohm, 1996	Bohm, D. (1996), On Dialogue, Routledge
Brown and Duguid, 1991	Brown, J. S., Duduid, P. (1991), Organizational learning and communities-of-practice: towards a unified view of working, learning and innovation,Organization Science, Vol. 2, No. 1, 2/1991, p. 40
Kuhn, 1971	Kuhn, Th. S. (1971), La Estructura de Revoluciones Científicas, Universitaria
Maturana,1988	Maturana, H. (1988), The ontology of observing, Irish Journal of Psychology: 9/1, p. 25-82
Maturana, 1997	Maturana, H. (1997), La Objetividad - un argumento para obligar, DOLMEN
Morecroft and Sterman, 1994	Morecroft and Sterman, (1994), Modeling for Learning Organizations, Productivity Press
Rodhain,1997	Rodhain, F. (1997), “La construction et la confrontation de répresentations: le cas des besoins en information”, Doctoral dissertation, Université de Montpellier II
Polanyi, 1983	Polanyi, M. (1983), Tacit dimension, Peter Smit, 1983
Popper, 1990	Popper, K. (1990), La lógica de la investigación científica, Tecnos
Roy, 1985	Roy, B. (1985), “Méthodologie Multicritère d’Aide à la Décision”, Economica
Schaffernicht and Pereira, 1998	Schaffernicht, M. and Pereira, J. (1998), Building a flexible management system, Working paper of the “Departamento de Informatica de Gestión, Universidad de Talca”; ask copies at martin@pehuenche.utalca.cl
Schon, 1983	Schon, D. (1983), The reflective practitioner: how professionals think in action,

	Basic Books
Winograd and Flores, 1989	Winograd, T. and Flores, F. (1989), Understanding Computers and Cognition, Abkex Publishing
Winograd, 1996	Winograd, T. (1996), Bringing Design to Software, Addison Wesley

7 Appendice: a brief introduction to ENLACES

In this additional section, we present the essentials of the ENLACES initiative in which the presented method is used; also, we explain why this seems a relevant "laboratory".

7.1 ENLACES as part of the chilean educational reform

Today, three kinds of schools provide basic and secondary education to chilean children: public, private-subsidized and private-payed. The ministry of education has responsibility for defining and overseeing minimum general standards, and at the same time, it is the superior instance for the public schools, that depend directly from their respective community (municipality). Chile has a high concentration of revenues, and so it is not surprising to see the vast majority of families send their children to the free public schools; those who are able to pay a bit use private-subsidized establishments, and relatively few can afford private-payed schools.

Due (though not only) to the scarcity of finance, the quality of schooling is roughly equivalent to what families actually pay. In this situation, the ministry of education has set up “the reform” and a special programme for the improvement of equity and quality in education (“MECE: Mejoramiento de Equidad y Calidad en la Educación”) under the motto “good education for everybody”. The basic idea of this reform may be called “local autonomy” (decentralization), which is thought to free schools from bureaucratic burdens and allow for pedagogical and administrative innovations and progress.

Part of the reform is ENLACES (spanish for “links”), which is an initiative that searches innovation in pedagogy and administration, as well as autonomy by the massive introduction of computers into schools. Currently, this means installation of a peer-to-peer PC network with MS Windows 95, the MS Office 95 suite, a shared printer and a phone-line with modem for inter-school communication, and the “Plaza” software; together with the installlation, there are two trainig courses and technical support during a limited period of time. The heart of ENLACES is a software called “La Plaza”, which is an on-screen “plaza de armas” (the central place in chilean towns), specially designed to be easily understood by kids. The “Plaza” offers electronic mail and interest-lists, as well as access to educational software packages.

On the organizational side, the ministry has formed “zonal centers” (ZC) that are in general universities that assume responsibility for determined geographical spaces, in matters of technical implementation and trainig provided to schools. Each zonal center hires “executing units” (EU) which will actually carry out the technical supply and training. Inside the target space defined by the ministry as “innovation (pedagogical and administrative) and autonomy by informatics”, each actor is free to manage and act as he understands; the national coordination (at the ministry) visits each zonal center in turn, to stay informed about the local advances and difficulties.

7.2 Towards the definition of a problematic situation

The concepts directly mentioned by the objectives-statement (at the level of the national coordination) are *innovation*, *informatics*, *pedagogy*, *administration* and *autonomy*. This could make one expect the intervention into schools to be designed such as approaching all of the issues. However, the practice of training and support has been limited to informatics. This is one possible choice, but we may wonder wether it has been taken consciuosly, in an informed manner, and wether other possible choices have been tried out or its validity is being tested.

Inside the informatics training and support, other choices have been made that are not part of the ministry's objective statement. For example:

- training is distinguished from technical support; (however experience shows that a lower level of user skills comes along with a higher demand on technical support, with a causal relationship from the first to the second.)
- training is divided into two separate courses, the first of which is intended to build "basic user" culture, and the second proposes educational applications; (however, it has not been made explicit what exactly has to be understood by "basic" nor by "user", and the software distributed with the "course 2" uses the computer as an encyclopedia rather that a tool for simulation, for instance, which is another implicit choice; different choices seem to be possible, and we do not know why things are as they are.)
- each executing unit has liberty to design and carry out its own training and support, as long as it respects the ministry's objectives and the above mentioned choices. There is no systematic use of already made experience in order to improve the quality of the one who made the experience, nor of helping to provide orientation to starters-up. Recently, a common manual intents to norm down the possibly existing diversity, which may be seen as one possible choice to un-do the problem of dynamically "control" (in the cybernetic sense) this diversity; (however, instruments for rapid accesso to valid information might be an alternative that would not be anti-diversity.)
- quality of output is assessed by supervision visits that focus on input; evaluation by mapping the innovativeness of participating schools after participating into the training against the type of trainig provided, in order to distinguish patterns inside the multitude of courses provided to about 2,000 schools (up to now), is not part of current practices. Recently, an ex-post impact appraisal on what has happened in the first ENLACES sites has been bought from a consulting firm; (however, Internet and remote database systems may provide a base for configuring instruments for faster in-process feedback at a lower cost.)

One last choice needs some explanation before being cited.

According to Polanyi (1983), we act basically in a tacit manner (what Argyris, 1993 calls "skillful"), and when we try to make explicit descriptions of these processes, we first lose our skillful acting by the decomposition, and later on we may "compile" it back into readily available knowledge for action. In this sense, innovating is what Schon (1983) calls "art": it may well be rigorous, but it lacks a degree of explicitness to be "scientific". These capabilities are learned as "becoming part of a community of practice " (Brown and Duguid, 1991), and Kuhn (1972) writes that even scientific practice is learned this way.

It should make sense, then, to expect that innovating is best learned by participating in innovative activities, and in this sense the ENLACES interventions might be an opportunity to generate such an experience. However, ENLACES looks for innovations in schools, not in itself, and nothing in the organization between the ministry, the zonal centers and the executing units seems to aim systematically at fostering innovation at these levels.

Thus, we distinguish spaces left to explore, in which both single-loop and double-loop learning would contribute to effectivity, and in which the parallelism inherent in the system would allow to validate information and share it across the country-wide organization. We use our observation that such efforts are currently not made, to bring in our own proposal.

7.3 The global "infotecture"

Putting the parts together, one obtains a global image of a possible organizational action/learning process inside the domain of ENLACES. In Fig. 8, we show the three levels of ENLACE's organizations (M for ministry, ZC for zonal center and EU for executing unit) in their respective OMCA cycles. One can see two important things. First, the actions and what is constructed at one given level in the organization are observed by the next lower level, for which they constitute kind of a frame. For example, the zonal centers take the rules and the perceptible behavior of the ministry (memos, visits, tools, coordination style and so on) as part of the world in which they move. Second, the observations made at one given level are available for observing at the next higher level. For instance, when an executing unit observes a high rate of learning in one particular content, the zonal center (and thus the ministry) will observe this, too.

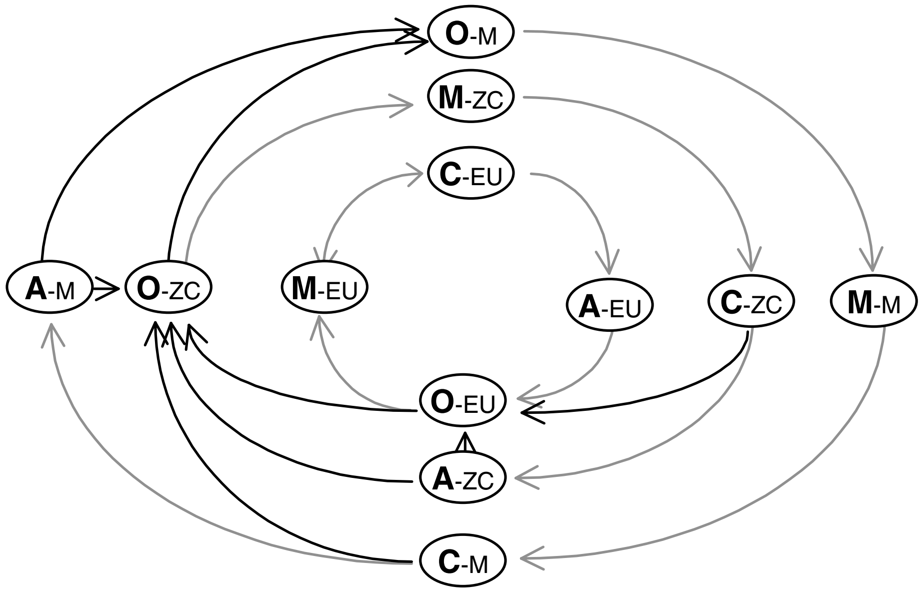


Fig. 8: OMCA at the different levels of ENLACES

This way to look at the whole organization reveals that there is a network of interacting cyclic processes, where each is an autonomous system (operationally closed in the sense of Maturana, 1988). This allows to stress the importance of learning processes at each level: if we wish to design a global system of autonomous systems in structural coupling (co-evolving), there have to be the connections *and* the internal processes that are to be triggered by interaction. Any attempt to constitue a high-performance executing unit is conditioned by the existence of a high-performance zonal center and vice versa. The same holds between the zonal center and the ministry.

We observe that it is of great importance to approach ENLACES from a systemic (uniting or global) perspective, with a special attention to structural coupling (Maturana, 1988) between the actors at their respective levels.

As for the time-horizon of each of the cycles, it is important to keep in mind that the illustration oversimplifies the processes; as seen in the paper, there are various cycles at each level (one for each *activity*). Accordingly, some of the proceses cycle faster than others. However, this does not interfer with the general statement of that the processes interact. We may anticipate that a given process *p* at level *l* will have a time-horizon of not less than the processes at level *l-1* that inform process *p*.