Natural Modeling – Retrospective and Perspectives An Anthropological Point of View

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ABSTRACT

Is extreme modeling so extreme? We advocate that natural modeling might be a better term. After all, the ultimate goal is to enable modelers to perform their job naturally. In the century of the "disappearing computer", it definitively makes sense to search for non invasive and flexible modeling technologies. This paper considers modeling from an anthropological point of view. A retrospective starting back to the Prehistoric Age leads to new perspectives for natural modeling in the Information Age. It is shown (1) that the need for compromises between flexibility and formality is "natural" rather than "extreme", (2) that the languages are emergent by nature, and (3) that natural interfaces should be provided to all stakeholders. We advocate that surface computing, tangible user-interfaces, collaborative modeling and emergent (meta)modeling are future research directions to be investigated in order to make "extreme" modeling just "natural". Just as it should be.

Keywords

Natural modeling, software languages, model, enterprise modeling, emergent modeling, natural interactions, history of information technologies, software anthropology.

1. INTRODUCTION

In the last decades, the focus of attention of mainstream modeling research has shift from *modeling methodologies* (e.g., SASD, SADT, or Merise in the 70's and 80's, and OMT, OOA/D, OOSA, OSE in the 90's) to *modeling languages* (e.g., UML in mid 90's), and finally to *modeling technologies* (e.g., EMF, GMF, QVT). Because of these recent dedicated efforts, models can now be produced, edited, transformed and managed with computers. However, modeling remains and will stay, just like software engineering, intrinsically a human-intensive activity.

While the main stream of research is techno-centric, this paper adopts an anthropo-centric perspective: *stakeholders* involved in modeling activities are at the center of the study, and modeling technologies are *means* to support modeling activities.

Here, we are more interested in understanding the deep *nature* of modeling rather that than the details of particular (transient) modeling technologies. These details are important for the current state of affairs in modeling, but this is not the topic of this paper. **The goal of this paper to study the past to understand the present and elaborate paths for the future**[1].

For instance, EMF is considered *today* as the standard de facto in MDE. But this is with no doubt just a particular and transient technology. Modeling can be traced back to the Stone Age [5][2][1]. This paper shows that the very notion of model and languages can be interpreted consistently all along the history of mankind, and in particular in the context of the history of Information Technology (IT) with its corresponding "revolutions" [7][9]. In spite of the *current* use of the term, Information Technology is *not* synonymous to the use of Computers.

By studying modeling practices coming from the Early Ages of mankind, including Prehistory, we are interested in understanding which modeling technologies have been "natural" enough to emerge at some point among human groups and crossed various millenniums. If a concept or a principle has been stable for various millenniums, it is likely that we should consider it seriously when planning further research in modeling [10]. By looking backward to understand what was *natural modeling in past*, this paper aims at defining some elements of what could be *natural modeling in the future*.

The remainder of the paper is structured as follows: section 2 lists some modeling and linguistic fundamentals. Section 3 provides an historical retrospective of natural modeling. Section 4 describes the Computer Age. Section 5 considers modeling in the context of large enterprises. Section 6 lists some research perspectives. Finally, a short scenario is provided in section 7 to give a flavor of what natural modeling could look like in the future.

2. FUNDAMENTALS

While programmers might consider that a model is a file written using a particular format (e.g., XMI), this paper takes an holistic view on modeling.

2.1 Modeling fundamentals

The corresponding assumptions, concepts and terminology will be reused all over the paper. These are truly fundamentals.

(A1) Different *stakeholders* with different *skills* and *concerns* are *collaborating* and *sharing* information in the production / description / exploitation / management of a *system.*
(A2) A *model* is a (partial) *representation* of a *system* elaborated with *symbols* to address the *concerns* of one or more *stakeholders*.
(A4) Whatever the *form* taken by a *model* it conveys some useful *information* about the *system* under-study. The *symbols* can be *interpreted* by the *system's stakeholders*
(A5) A *model* can be *produced* by one *stakeholder* and *consumed* by another *stakeholder* leading to synchronous or asynchronous *communication* between stakeholders.
(A6) A *metamodel*, which is also a model, is a (potentially partial) *representation* of a (modeling) *language*.
(A7) To ensure *stakeholders* share some common understanding about a *language, metamodels* can be established and *shared.*
(A8) A *modeling tool* is a tool that allows building, storing, analyzing, and transforming models by *interacting* with them.

[1] For space limitations we provided a few key references. The reader is invited to consult [8]. See http://planet-sl.org/topics/natural-modeling/xm2012 provides additional information.

2.2 Linguistic fundamentals

As modeling is intrinsically bound to the notion of *language*, the science of languages, that is *linguistics* [6], constitutes a good Body Of Knowledge (BOK) from which to derive more elements.

(A9) According to mathematical linguistics and the formal language theory, a (modeling) *language* is the *set* of (modeling) "utterances". In our case, it is the set of all models formed by *symbol* combinations compatible with the language. A *language* is a *system of symbols* governed by some rules.

(A10) From an anthropological point of view, a language is considered as a *social phenomenon* involving a *community* of actors [6] (*stakeholders* here). By virtue of the existence of a common *language*, stakeholders have the ability to engage in *interactions* and *share information*.

(A11) *Language emergence* and *language evolution* must be considered as intrinsic properties of languages [3][4]. .

(A12) *Language transmission* and *language acquisition* are fundamental processes as they ensure the transition between an existing *community* and a particular *stakeholder*.

(A13) Just like languages, *proto-languages* are *systems of symbols* characterized by a low level of structural sophistication [6], no established *rules*, and very *flexible* and *fluctuant usage*.

(A14) Some *proto-languages* are potentially *emergent languages* that under certain conditions could convert over time to full-blown language within a *community* of practice [24].

(A15) A *pidgin* is a form of proto-languages that emerges as an ad-hoc means of communication or representation between two *communities*. Pidgins emerge in the context of repeated *situations* where some *stakeholders* having different *concerns* do not share the same language (e.g., trade between different cultures) [6].

(A16) *Special Purpose Languages* (or *Domain-Specific Languages* (DSL)) are languages dedicated to specific *concerns*, *situations*, *communities*, *skills*, or *domain* of discourse.

3. FROM STONE AGE TO THE PAPER AGE

The concepts presented so far are *not* bound to a particular technology or period of time as shown by the retrospective below.

3.1 Early Prehistory

Sharing *information* about a particular *system*, for instance a group of mammoths, was a matter of survival in prehistoric times. Hunting required the *collaboration* between different *stakeholders*, here various homo-sapiens having basically the same *concern*, finding food. As one could imagine facing the system (the mammoths) without previous planning was not the best option. Exchanging *information* about the mammoths enabled to plan the attack safely [3]. The question is therefore how did they represent / model information in such a context.

A precise answer to this question would be speculation. The biologist anthropologist T. Deacon describes homo-sapiens as a "symbolic species" [3], a biological feature that give us modeling abilities. Homo-sapiens could indeed rely on various *modalities* of communication / representation to model information.

Body languages assign meaning to parts of body or gesture [6]. Although there is no evidence for that, counting on fingers might be one of the first *computing* techniques ever "invented". Information about location of mammoths can also be *signaled* in hunting *situations* by means of *gestures*.

Spoken languages assign meaning to *articulated sounds*. Spoken language enabled homo sapiens to not only (1) to elaborate and discuss much more sophisticated hunting plans, but also (2) to accumulate and *capitalize knowledge* over generations through *oral transmission* leading to so-called *oral cultures*.

Visual languages assign meaning to *visual symbols* represented typically in a 2D *surface*. Drawing a map on the floor with visual elements representing the location of animals, rivers, rocks or refuges was a modeling technique certainly in use during the Stone Age. The consistent reproduction of some symbols (e.g., male and female genital attributes) suggests some common *rules* were probably in use when creating these *proto-models*.

Tangible languages assign meaning to 3D *objects*. For instance in a planning or narrating hunts, each mammoth could have been represented by a pebble, hunters by seeds or whatever objects at hand. Moving these objects allow to *simulate* hypothetic hunting situation or describe past situations. Such very primitive yet natural modeling technology can stay in the form of a *transient proto-language* if the conventions of representation change between successive modeling situations. But if conventions start to *emerge* among a *community* of *stakeholders*, this could turn into a *proto-language* and may be into a full-blown language.

In non-trivial modeling situations *stakeholders* are *naturally* engaged in *multi-modal interactions*. For instance a primitive visual representation must be accompanied by some oral *narration* to be interpreted properly. Gestures combined with words like "this" are *natural* multimodal interactions. The lack of *formality* of a language is *compensated* by an extra interaction in the form of a *disambiguation dialog*.

Summing up early Prehistory is characterized by (1) the domination of nature over homo sapiens, (2) the emergence of very primitive and multimodal (proto-)languages, (3) a very limited list of *concerns* for "*stakeholders"*, basically finding food and making love.

3.2 Neolithic

The **emergence and consolidation of proto-writings** [5] is one of the characteristic of the Neolithic period. Concretely, proto-writing is materialized for instance by Sumerian clay tablets [2]. Retrospectively this could probably be considered as one of the most important contributions in the history of *modeling* and *Information Technology* [1][7]. It was indeed the first time that rather unambiguous and *precise information representing* a *system* was systematically *recorded* and *stored* explicitly on a *persistent* media for later consumption [2][5].

The transition to **surface-based structured modeling** is described in [2] as a possible evolution from (1) *tangible modeling* from early prehistory (e.g., the use of pebbles or seeds), to (2) clay tokens and (3D) bullaes, to (3) *established symbols* recorded on a 2D *surface* of clay tablets and finally (4) establish structures of symbols with increasing level of *syntactic* and *semantic rules* (e.g. is some cases the sum of quantities recorded on the obverse of a tablet should be written on its reverse [5]).

The **emergence process of proto-writings** has been studied systematically in the recent years constituting an important Body Of Knowledge [5] to understand what modeling is truly about.

The separation of concerns and the notion of stakeholder can be also traced back retrospectively to the Neolithic. The domestication of Nature led to farming and culture. The possibility of surpluses in food production led in turn to the diversification of human *activities* (e.g., butcher, weaver, farmer, shoemaker, etc.), *domains* of knowledge, and in fact to *separation* *of concerns* among *stakeholders*. It is in this social context that IT emerges in the form of *domain-specific proto-writings* to support various human activities such as trade or work management.

3.3 From Antiquity to Middle Age

The invention of written languages is considered as one of mankind's greatest achievements as it marks the shift from *Prehistory* to *History* [7][41]. Technically, writing arose from the generalization *proto-writings* [5]. While proto-writings typically correspond to *domain-specific proto-languages*, writing can be seen as a *general-purpose modeling language*. The trick was to understand that encoding (at least some part) of *oral language* into written symbols would allow to express everything.

In early antiquity this number of people in social group has dramatically increased up to thousands and millions in antic cities, kingdoms and empires. The number of participants in a social groups matters: *oral communication* cann*ot* scale up under a certain limit.

The apparition of civilizations is characterized by increasingly complex eco-systems of stakeholders. Just like in current enterprise settings and global organizations, the number of *professions* and *stakeholders* increased significantly with people being affected to tertiary sectors in the service of the state such as laymen, commanders of military forces, accountants, tax collectors, land rulers, etc.

Model management appeared as a necessity to deal with the profusion of documents. Various techniques such as colophons or other storage and indexing mechanisms were invented to deal with increasingly numbers of models but also to establish references between models.

Proto-metamodeling appeared in order to share and transmit knowledge and rules governing *written languages*. (Partial) models of languages, that are *metamodels*, were realized in the form of glossaries or domain-specific vocabularies. For instance some clay tablets list systematically the names of each profession or the list of objects that can be produced from wood, representing first Body of Knowledge and ontologies.

Proto-conformance or *manual conformance* checking was the rule during Antiquity. That is, the conformance metamodel had to be ensured by the scribe producing the model. That was precisely the purpose of the acquisition of writing skills. A Sumerian text relates how pupils' errors during conformance checking were signaled by the school master via a stick [41].

3.4 From Middle Age to Modern Age

Due to space limitation it is clearly not possible to relate here all important events that occur in terms of modeling between the Antiquity and the Computer Age. The reader can imagine however how the history of: mathematics, cartography, architecture, heraldic, accounting, etc, are full of examples describing the *emergence* and *evolution* of *domain-specific languages*. In all the cases, tensions between more *formality* and more *flexibility* can be found. In all fields the emerging and social nature of languages can be demonstrated (even in field of Mathematics). In all cases, the evolution of languages is linked to socio-technical reasons. Passionate debates between visual or textual languages, highly symbolic vs. more concrete languages can be found in many periods in history and across many fields.

Ultimately, the end result is that there is no silver bullet and that *language variations* and *language integration* must be considered as a matter of fact in non-trivial situations, that is when one takes the reality into account with the variety of concerns, stakeholders, skills, supporting technologies, modeling situations, or cultural traditions and transitions.

3.5 The Age of Reason

The period 1700-1850 is characterized by the "scientific culture of information systems" [7].

Language of sciences. includes for instance Lavoisier' nomenclature and Linnaeus' classification that revolutionized Chemistry and Biology respectively. They are still in use today.

Scientific models made their apparition. For instance cartography turned into a scientific activity. Statistics emerged as a way to provide numerical models summarizing static or dynamic properties of complex systems. This period is characterized by the intellectual need of *systematization* and *formalization*.

Model-based management became a requirement for various nations. Ambitious projects involving cartographic and statistical models were developed at the national level. Scientific models such as maps or population census became means of governance.

3.6 The Paper Revolution

The period 1800-1940 is described in [9] as the Paper Revolution.

Paper-based technologies were developed for structuring and managing paper-based models. This includes files, records, forms, cards, templates, folders, punched cards, storage and retrieval mechanisms, classification and reproduction techniques, etc [9].

Paper-based workflows were put in place with a huge impact on *information processes*, leading ultimately to systematic *processes* where *models* had to transit between offices or departments and to *interpreted, transformed* and *analyzed* by many *stakeholders*.

Model systematization was the condition *sine qua none* to the *instrumentation* and *automation* of *information processing* tasks. While most information would have been transmitted previously in the form of unstructured texts, filling *forms* became the predominant way of representing domain-specific information. *Templates* governing these forms played the role of *metamodels* whereas the filled forms themselves were *structured models*.

Automation of information processing processes started with reproduction machines, addresses printing, automatic cards retrieval, etc. The use of punched cards and the invention of tabulating machines ("mecanographie" in French, literally "mechanical writing") lead at the end of the 19th century to the creation of companies such as IBM in the next century.

4. THE COMPUTER AGE

The end of flexibility and the exclusive focus on automation characterize the "*Computer Age*". This age, characterized by the domination of computer, lead the profession to a *techno-centric view*. We claim that an *anthropo-centric* view should be considered to make progress in the area of modeling [10]. As shown below the evolution within this age somehow follows the path described in the previous section from Prehistory, Neolithic, to Civilizations as organizational constructions supported by IT.

4.1 Prehistoric Informatics

Domination of computers over programmers is one of the main characteristics of the Prehistory of Informatics, in the same sense as the Domination of Nature of hunters-gathers in Prehistory.

Because *automation* was the *exclusive concern* (just like finding food was homo-sapiens *main concern*) all efforts were dedicated deal with the machine. Executability became a must.

Prehistoric Informatics characteristics include (1) typically *small teams* of (rather asocial) *coders*, (2) the domination of *computers*, (3) the confusion between *Programs* and *Software*, and (4) the confusion between *Computer Science* and *Informatics* (5) a very strong *techno-centric* culture, (6) the belief from "real" programmers that models and visual languages are for sissies.

4.2 Neolithic Informatics

Neolithic Informatics is characterized by (1) the control taken by humans over hardware problems, (2) the progressive shift of attention from *hardware* to *software*, (3) an increase in terms of group sizes, (4) a first recognition that producing software required first level of collaboration, (5) a first level of *separation of concerns*, and (6) a first distinction between *stakeholders* roles (e.g., testers vs. programmers, etc).

5. TOWARDS CIVILIZED INFORMATICS

In the history of mankind, the apparition of first civilizations is characterized by increasingly complex social organizations, leading both to (1) unprecedented constraints on IT and (2) the generalization separation of concerns and professions of all kinds. While cities, states and kingdoms where at the origin of this shift, nowadays social structures that drive this movement include not only states but also all kind of large corporations and enterprises (which size could exceed size of antique cities). IT became a mean for *governance* in Antiquity and upwards. This remains the same. To envision the future, one should forget the exclusive focus on computers that marked the beginning of informatics.

5.1 Languages in Enterprises

The development of modern organizations, and their supporting IS involves a large variety of *stakeholders* with large variety of *skills* and even larger variety of *concerns*. The need for different perspectives/viewpoints was acknowledged quite early in Information System engineering (e.g., [18]). The emerging fields of Enterprise Architecture (EA) and Enterprise Engineering (EE), extends this to an even wider range of views [15][16]. *Communication* skills between heterogeneous teams of *stakeholders* becomes crucial, hence a huge pressure put on modeling and many linguistic issues in modern enterprises.

Holistic view in enterprise, like cartography in the past, is needed for having a good view on *management, governance* purpose and understanding what happen in the boundary of a stakeholder job. However, such unified view could not be achieved by *unifying* all the languages used. Everyone needs its own language specificity in his/her everyday work. Thus the fundamental issue is resulting in communication facilities. This means ultimately more models in all kind of forms and the need for flexible model management.

Whilst a series Unified Languages aims at being a new *lingua franca*, they do not solve the problem of common misunderstanding and cross-cutting concerns. An illustrative phenomena in enterprise is seen by the tension between IT and business people: the first group aims at having "formal" models in order to solve IT-based problems (notably software engineering) whilst the second one claim for more *flexible* languages to express their own concerns. However, all the parties need to understand the limits and requirements of the other domain in order to reach the coherence needed for the enterprise to follow its path. The needs, concerns and skills of the different stakeholders skills is one driver for diversification of languages the enterprise. What is needed is neither computer languages, nor pure natural languages; probably something in between, something that could fit under the name "software languages".

5.2 Communication needs

In all cases, all kinds of languages are to be used in enterprises settings, in some situations of another. Some of the *communication* is expected to be solved by oral communication with less formal concepts called *yellow print thinking* by [17] by opposition to *blue print thinking* which are driven by engineering principles. Such communication aims at bringing the necessary common ground understanding [11] for each stakeholders.

This action helps notably in reaching the corporate vocabulary, understand impact of personal work as well as providing insight of enterprise wise strategy. This way, pidgin between domains composing the whole enterprise can be founded at the boundaries of stakeholder's works. Interfaces between linguistic boundaries are therefore particularly important, just like the linguistic architecture of the enterprise.

The need of comprehending and analyzing cross-cutting concerns amongst *stakeholders* implies to communicate via *models* of all kinds. Reaching a holistic view is also a need for enterprise managers providing them with various indicators for strategic decisions. Alike the cartography and statistics were means of ensuring governance in the 18th and 19th centuries.

Modeling is certainly an important part in the future of enterprises (and beyond pure IT), but modeling should become first more natural.

6. TOWARDS NATURAL MODELING

While a *retrospective* on natural modeling has been presented in the first part of this paper, this section describes *perspectives.*

6.1 Natural Interfaces for Modeling

If we want to achieve *natural modeling* and ubiquitous modeling in enterprises, the best orientation is probably to improve the way we interact with models. Current CASE tools are difficult to use because of their poor ergonomy, crude absence of *flexibility* and lack of support for collaborative work. That's why most modeling activities in enterprise are done on whiteboards or paper.

Fortunately new opportunities exist. Weiser described his vision for "The Computer for the Twenty-First Century" [12] as disappearing computers. That is interactive systems should be hidden (as much as possible) so that stakeholders can interact freely with tangible (3D) objects or using techniques such as *writing* or *drawing* on a (2D) surface. Weiser' vision has led to *natural interfaces*[2] [22]: a wide range of emerging technologies are being developed currently. We advocate that most of them could be used in the context of natural modeling, leading therefore to important research perspectives.

Surface Modeling (e.g. using a clay tablet or a piece of paper) has always been one of the most classical ways of creating models. Nowadays, *Intelligent Paper* techniques [19] enable to

[2] See http://naturalinteraction.org/ for examples.

recognize handmade writing and shapes. Diagram recognition [30] including UML recognition [29] are important topics. When using the *Magic Paper* [33], models can also be use and changed dynamically after recognition. Pen-based interfaces can be completed as well with direct surface interaction using hands and fingers recognition [21]. Natural/controlled language processing could also enhance natural interaction (e.g. natural MDA [40]). **Tangible Modeling** is inspired by tangible user interfaces [13]: using real life object as a representation of the *system under study*. Tangible Modeling is a natural act in everyday life. Just like homo-sapiens in prehistoric times, we use objects available at hand during coffee breaks or informal meetings to indicate geographical positions or to narrate more complex modeling stories. Tangible programming introduced in [25] is an example of tangible modeling interaction.

Multimodal Modeling is based on multimodal user interfaces defined in [23], which combines different kind of interactions such as tactile, vocal or haptic. Multimodal modeling is natural (e.g., to give meaning of a drawn shape with voice). There are various examples in the research literature such as [26] for enhancing flexibility or for annotating models [37].

Multimedia modeling is based on the multiplicity of means used to convey information such as pictures, video, audio records, etc. This modeling type advocates the use of different media (e.g. video [38]) for recording the rationales behind some models.

6.2 Emergent (Meta/Mega) Modeling

MDE call upon having a well-defined but also fixed metamodels in order to achieve modeling sessions. As mentioned in Section 3.5, the ratio between the machine language (strict and fixed metamodel) and the stakeholder aptitude should be balanced. Flexibility in terms of metamodels and associated tools is pursued. Informal modeling is necessary during communication while more formal elements are required in other situations.

In enterprise, tension between and among stakeholder's languages, machine languages should be managed as a cursor on the level of flexibility of modeling language. This level of flexibility allows for both defining freely models and being able to infer more formality, e.g. infer a metamodel structure.

Thus, we refer to the concept of **emergent metamodel**, a metamodel inferred from existing models. This concept follows the idea of [35] where authors infer the metamodel from annotations given on the model; this notion is related to the concept of programming by examples.

Metamodels emergence raises issues (especially when models are collaboratively built) such as incompleteness, uncertainty or conflicts. The conflict resolution problems are notably addressed for EMF in [31]. The uncertainty or incompleteness of metamodel is found the analysis of usage of the multiple models constructed by stakeholders, tracing use of model inside the metamodel [32]. In addition this helps in identifying which specific metamodel correspond the language used in a particular context. Just like ontologies produced independently have to be aligned, metamodel reconciliation and convergence are important topics.

According to [36] the definition of modeling editors is an important step to achieve flexibility. But with the current state of the practice, the creation of full-blown editors is too heavy for most stakeholders. Emergence of modeling editors should allow the reuse of a model syntax (and emerged metamodel) between modeling sessions, without too much initial work.

Finally, all elements (models, metamodels, editors, stakeholders, etc.) that emerge in a community or enterprise, should be considered in the context of an **emergent megamodel**. Indeed, all the elements that compose the megamodel should also be manipulated and represented by (natural) interfaces [39]. Through this megamodel, we express the cartography of languages in their context of use. This **linguistic architecture** includes languages boundaries, traceability among models, metamodels and languages, evolution of emerging metamodels, of stakeholders concerns, etc.

6.3 Collaborative & Social Modeling

Natural interfaces (see section 5.1), such as interactive tables, encourage the share of modeling spaces amongst peoples. Moreover the flexibility of metamodels (section 5.2) permits to encompass multiple stakeholders with different backgrounds.

Following the idea developed in [14] the flexibility introduced by natural modeling should lower the barrier of modeling. Thus, the information collected by (meta)modeling sessions encompasses the views of multiple stakeholders.

According to such a paradigm, a modeling session becomes a social act where knowledge about the system under study is shared between the modelers. It permits to discuss directly about concepts; each stakeholder is thus a potential source of information. They contribute to modeling landscape and thus the "collective" model is a media to drive collective intelligence.

The term *social modeling* can be interpreted in two manners: (1) the traditional way, where models represent a social system (stakeholders, individual values, communication, etc.) (2) *social modeling* as a social activity creating models involving many stakeholders of a system (engineers, designers, end-users, etc.)

Various tools and methods promote some form of collaborative modeling (e.g. Collect-UML [28]). Some of them have specific objectives, notably language acquisition [27]. Finally, some work relies on natural interfaces to enhance collaboration [20].

7. BACK TO THE FUTURE

With cave paintings homo-sapiens provided us examples of how natural modeling should be. As torches or fires were used to get some light under the Earth, paintings were "animated" by the flames (see Figure 1 on the left). According to some anthropologists, this could have been interpreted by our ancestors as a way of bringing some "life" to the system represented. The purpose of such a modeling is unknown to us, but it could be some form of *simulation* or some way to *act* directly on their world through shamanic power.

Figure 1. Retrospective vs. Perspectives on Natural Modeling

Thanks to technologies such as the "magic paper" [33], we don't need any more shamans to bring live to our models. An example of what natural modeling could potentially look like in the future is depicted on the right of Figure 1. The image is an excerpt of a famous video [34] showing the use of a natural modeling prototype [33]. Remote participants and a legend have been added this picture for the sake of illustration.

A scenario for natural modeling could be as follow. Some stakeholders are drawing collaboratively a model. During the session a remote participant suggested to add to the modeling language the notion of spring (a metamodel of the current visual language is displayed in a legend form). While some participant entered on his tablet the corresponding physical equations to simulate behavior of these objects, other participants created a model to test this new addition. The picture displays the instant where this model is about to be finished and a participant is about to bring model to live (via the run button). As one should expect, the balls will naturally ride down the slope, then fall and will eventually (or not) end their course into the basket.

The world is animated again but shamans have been replaced by invisible computers and a "run" button has replaced torches (see [34] and read [33] to understand some of the magic behind this natural interface).

8. CONCLUSION

In the last decade the MDE community did a great job in terms of *automation* in the context of modeling. However, we argue that it is time to consider not only *instrumentation* and *automation* of modeling but also its *generalization* and *adoption* in enterprise-wide context. This goes beyond modeling of IT, and it is time to realize that the notion of software languages goes far beyond computer languages as this notion is pervasive [42].

Current CASE-like tools are too hard to use and too rigid to support the increasing number of modeling concerns of enterprise stakeholders. Since the characteristics of Homo sapiens has not changed and will not change soon we must adapt computers to our human practices, not the other way around. It is time to complement the technological view by an anthropological view.

What is extreme indeed is not the nature of the modeling activities one can envision for the future, but on the contrary the number of disciplines and techniques required to make modeling appear natural, just as it should be.

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