Procedures modeling, adaptation, orchestration and reproduction with "functions"

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Abstract: The procedures that have to be executed or learned can be represented in passive models (useable for information only) or active ones (used in orchestration). On the other hand, knowledge learning and management processes can themselves be modeled. After a long study on the issue of modeling, learning, orchestrating, managing, adapting and reproducing knowledge based procedures, I tried to synthesis my perplexity in my PhD thesis. I have continued the research in the context of LICEF projects, experimenting the "functions" formula (term borrowed from biology to point out an organic and evolutionary approach)- with the help of the GEFO prototype. The investigation of the physiology of the global system formed by a procedure and its model, led me to manage the model's "lifecycle" with the help of "metafunctions". I expose here succinctly the functions' usage contexts, their structure and physiology, signaling the Knowledge Management applications.

Keywords: Process modeling, Workflow orchestration, Knowledge management, Procedures reproduction, Model life cycle, Functions and metafunctions, GEFO, Evolutionary engineering
Categories: H.3.1, H.5.3, J.4, J.7, K4,

1 Introduction

As a telecommunication or computer systems engineer or as a trainer in the electronic industry, or mathematics teacher, I was confronted to problems related with the management of complex processes and with the learning of procedural knowledge (construction or repair of a product, resolution of a problem etc). At the foundation of the methods I have explored, I have put the procedures' modeling-the model being subsequently used in the presentation (explication) of the procedure, in its reproduction (execution and learning) or in its orchestration (ordering of operation chains, coordination of cooperative processes). I exposed these preoccupations in some interventions [ROS 96] and synthesize some results in my doctoral thesis [ROS 99]- dedicated to the problem of modeling the explanation process. It was also then that I opted for principles that have oriented my research (see [ROS 06]) as:

Structure/process duality: existence/transformation, adaptation/evolution, ontogenesis/phylogenesis. The physical and conceptual entities, tied by relationships, create systemic units and determine their behavior (physiology). Conversely, the physical and cognitive processes sediment structures (entities and relations). A complete systemic vision must reveal the existence-becoming duality, using "structures in processes" models. The adaptation and evolution of a structure are intimately tied, defining its "life" as systemic entity. The ontogenesis of the being (of the individually experienced concept, of the object) and the phylogenesis of the species (of the collectively experienced concept, of the object production cascade) - are interlaced processes.

Conservation and change: circular relationships between "model" and "reality".

The modeling (description) of manifested or imaginary phenomena can orient future implementations in accordance with certain values and goals. But the reality must be observed and understood (modeled)- even if we wish to conserve it. A reciprocal influences loop is blend between "reality" and "model" (accentuated- when the phenomena's "model" is used as an instrument by the participants)- with major behavioral consequences. The "reality-model" system has its global physiology.

Co-action and synaptic tele-informational systems. The explanation of procedures can consist in the sharing of actions. A powerful form of assistance is the "pas de deux" operation: the expert does because he knows, the novice knows progressively - because he is helped to do. We can use novice-computer pairs (the expert is represented by a simulator) or the "triple command" work: the expert intervenes when the computer can't face to the assistance task any longer. But prior to cooperating or communicating, the partners must equip, find and agree themselves. And after, they must update the model that sustains their coordination. The computer network can provide contact, contract and management services, forming a "synaptic" (matching) infrastructure for the collective brain's physiology.

I have refined this orientation studying the problem of transforming MOT (LICEF conceived editor for the management of procedural knowledge, pedagogical scenarios and resource diffusion plans [PAQ 03])- towards the posture of a collaborative editor for cooperative procedures' orchestration scenarios-proposing the ADISA system [PAQ 01] as a compromise. Afterwards, working on the Explora2, SavoirNet and TELOS architectures [PAQ 02] I compared the LICEF pedagogical workflow (learnflow) modeling formulas with similar developments coming from CSCW (or CSCL)- analyzing the inter-operability problem sustained by norms like EML or IMS-LD [MAR 04].

In order to deepen the research about the physiology of the ensemble formed by the procedural reality and its orchestrating model, I have piloted the prototypal development (by Val Rosca- whom I wish to thank) of a "function manager" (GEFO- [ROS 03]). This instrument was then used and refined in the context of the LORNET project [explained in my communication for KSR], founding a prototype that has illustrate the behavior proposed for the TELOS system [ROS 04].

The main ideas of process modeling-managing through functions are: the versatility of the model-reality interaction and the management of its various "modes" with metafunctions; the support of man-machine ensembles' orchestration; the combination of scenarios (pre-action) with reflections (post-action); the continuation of abstract element definition with a chain of progressive concretizations; the indexation of components on a common knowledge and competences reference system; the use of these references to analyze the "competence equilibrium" around operations and to launch corresponding services (selection, matching, alerting etc); the propagation of the reactions emerging from function execution towards the referencing layers. All these features would permit to a system like GEFO to support the management of a global knowledge metabolism: incarnated and evolving in participants, incorporated in explicative resources, referenced in semantic declaration structures.

2 Procedure management with functions

Let's talk about process modeling, in a double hypostasis: as a learning subject, but also as a knowledge management means.

2.1 Procedures and their modeling

The following figure introduces progressively notions and situations of interest:

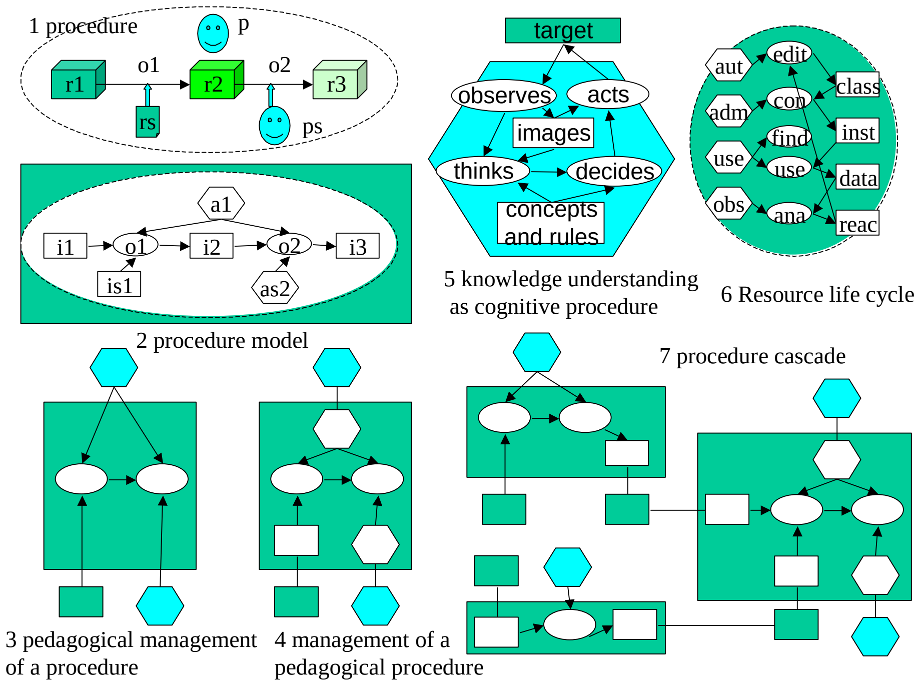

Figure 1: procedures' modeling

1 **The procedure.** A procedure has a dual character, as "structure in process". Structurally, it is formed by interconnected "components": persons (the executants p of certain actions and their assistants- ps) and objects (resources r- to be used or produced- or support resources rs). Processually, it consists of a chain of actions (steps, phases - o). The combining of the structural and processual approaches leads us to decomposition in interlaced "threads" (roles). Procedure aggregation can continue in both directions: the actions can break up in sub-procedures and the procedure as a whole, seen as unitary operation, can be part of an including meta-procedure. Someone can participate to a real procedure (as the one suggested by that dotted oval) or may wish to refer to it, using a symbol, a name or a model.
2 **The model of a procedure** - is a symbol structure, reflecting or imagining a concrete (with specified elements) or abstract (with generic elements) system-in-

process. It uses representations for the components reflected in its "mirror": actors (hexagons) - which can designate generic participant categories or specified persons, instruments (rectangles) - which can designate concrete resources or generic classes, operations (ovals) - designating particular or generic processes, realized or to be realized. Some models can comprise other symbols too, such as those dedicated to the possibility of "branching" (ordering) the actions depending on data obtained in a concrete realization of the procedure. The use of a generic procedure's model in piloting a real one requires the concretization of the elements (instantiation), accomplished in an order determined by the "working mode" (for instance: the resources are fixed first, then the support persons and finally the executors etc.) Some procedures are dedicated to a single actor, their purpose being to order actions and connect resources; others can negotiate the "flow-control" between the elements that intervene concurrently in an operation; other can manage complex scores for "man-machine orchestras"- combining connection, ordering and coordination.

3 **Pedagogically managed procedures.** To assist the execution, to present or teach a procedure - even a simple model of the operation chain can be useful. The participant exploiting such a model can interact with support resources and persons, although this assistance is not planned in the model. The pedagogical management of a procedure is a flexible solution, but it can create organization difficulties (finding support etc).

4 **Pedagogical procedure's management.** Suppose the explicit representation in the model of the support actors and instruments, reducing the freedom of the pedagogical arrangement, but assuring the conformance to the pedagogical intentions of the model's author. This one can specify the knowledge required by the operation execution, the competence profiles necessary for the actors, the "competence leap" provided by the support document. Such a "semantically indexed" model can assist the elements' concretization, so that the competence conditions required for the assistance be met (optimized). The competence profiles used in the model concretization phase or during the model execution can be updated after (learning).

5 **Cognitive procedures.** The external implication of a participant in a procedure is accompanied by an internal process (observing and reacting, thinking and deciding etc) and leads to a certain evolution of its knowledge. These cognitive processes can themselves be represented procedurally, if their exposure is useful.

6 **The lifecycle of a resource.** Some models can represent a resource's lifecycle chain: the edition of a new type (class) of resource - by an author, the concretization of resource instances adapted to different contexts- by an administrator, the retrieval and use- by various participants, the analysis of use data- by observers making recommendations, launching feed-back reactions etc. The composition cycle can continue, producing the aggregation of more and more complex objects [see also my communication for the KSR conference].

7 System procedures. A resource resulted from a procedure can be used in another - as an input or support object. A person implied in a process with cognitive effects can intervene in the execution (or support) of another. The procedures' models can support their binding (aggregation) in "production cascades". These chains form a "network of models" demonstrating, managing or coordinating the physiology of knowledge systems with complex metabolism [see the IKnow06 communication].

2.2 Procedure management; model-reality relationship

The key to the "function" methodology is the meta-procedural treatment of the report between a procedural reality and its model, the model's lifecycle being exposed as a metafunction, in the following figure:

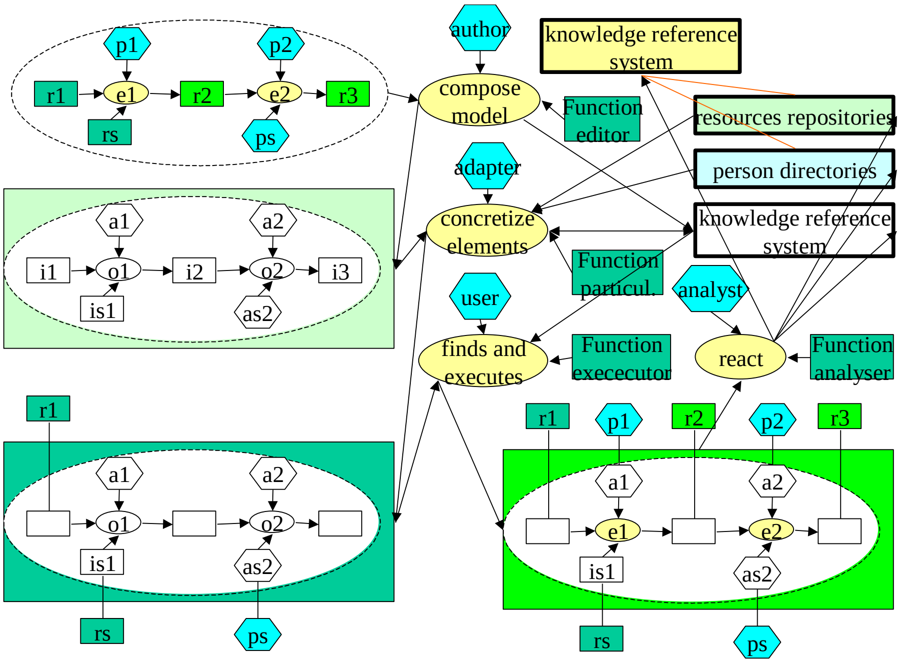

figure 2 The lifecycle of a functional model

1 Edition A real procedure is observed by an author, that conceives a model based on it, using a "function editor". The operations and elements (actors and instruments) are declared abstractly, allowing liberties for further concretizations, in the limits specified by the author (expertise required for the assistants etc).

2 Concretization. The function definition process can be continued, starting with the base (class) model. Concretization can mean specifying the final components or just restricting the selection criteria (administrative, technical, domain) for the connectable elements (for example, a "teachers" category can become "teachers specialized in college level Algebra, communicating asynchronously in French", an instrument defined as "lesson on matrices" can lead to "document initiating in matrices, in pdf format", an "understanding matrices" generic operation can become "taking place on-line at 1-04-2006" etc). An arborescence of increasingly particular "derivate" models can be obtained this way, leading eventually to "contracts" (allowing only the liberty of changing the potential users) or to a "scheduling model" (fixing all participants). The administrators operating concretizations choose the resources and the participants from the accessible repertories, using competence optimization services (if these repertories are indexed on a knowledge reference system) [ROS 05].

3 Execution. Is accomplished according to the scheduling or after free instance retrieval. In the case of adaptable instances, the participants can still concretize support elements at run-time, just before the operations' execution. The execution's results (data, annotations, traces, produced resources)- are put aside.

4 Reaction. Is based on the results' analysis and can include the modification of competence profiles and resource's indexation or even the re-organization of the knowledge reference system.

The meta-procedure exposed above can also be treated in GEFO as a metafunction. That offers us the possibility to define and manage the "life mode" of a function. We can, for instance, establish (observe, coordinate) modes as: the editor fixes only the topology of the implied operations, leaving the right to fix resources to the administrator, and to find support partners- to the executor. Or: the editor also fixes the support resources, the administrator allocates participants to an instance etc.

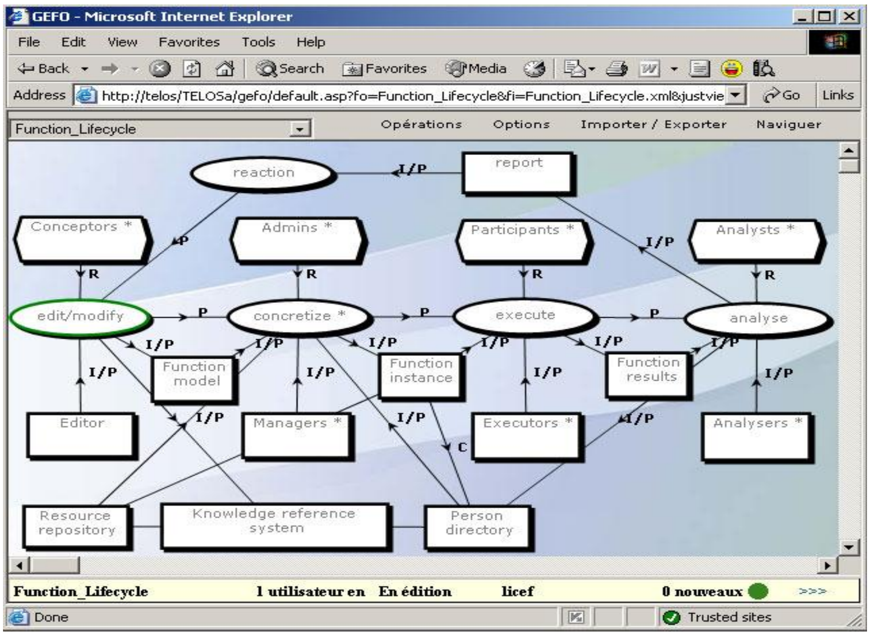

figure 3 Function lifecycle management as metafunction- in GEFO

2.3 Procedures' reproduction

The entire knowledge metabolism of a LORNET-like system can be represented (managed) functionally. Such a representation of the global process of reproducing procedural primary phenomena, modeling them and using these models to create more or less similar secondary phenomena (procedure "phylogenesis")- synthesizes the use cases of the GEFO function manager.

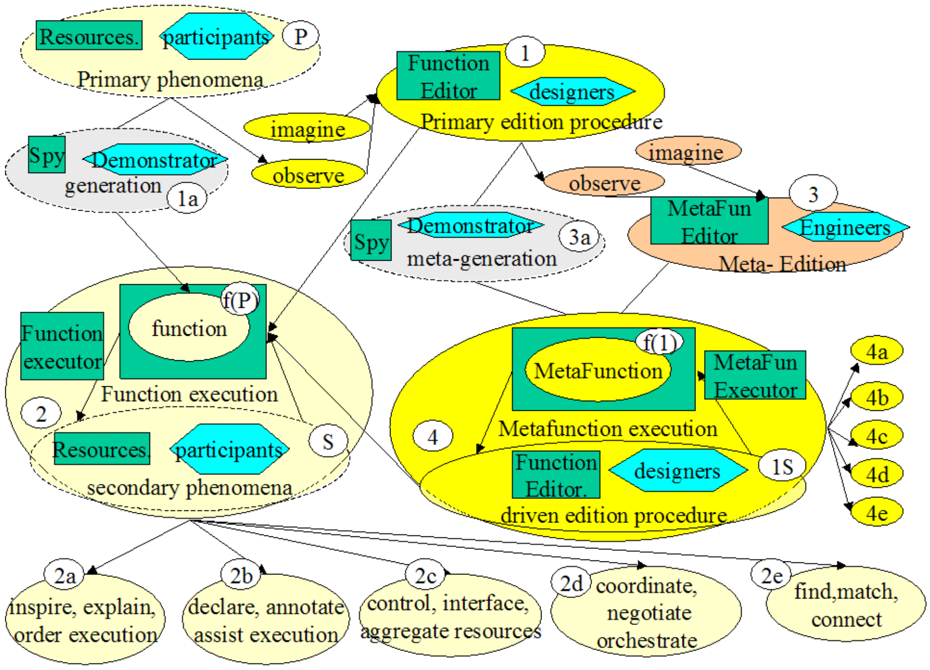

figure 4 Procedure "phylogenesis"

1. **Modeling.** A primary procedural phenomena P is observed (imagined) by the designers witch edit its model (and concretize the resources and participants).
1a. The "interception" of the normal or demonstrative actions (with the help of some "captors") can sustain the generation of pre-models, supporting the human edition
2 **Reproduction.** The primary phenomenon P is reproduced in a number of secondary phenomena S, through executions of the model- which can mean:
2a The model is used as an explicative guide, inspiring the actions' ordering
2b The participants declare and produce data relative to the exploration, witch the model memorize and use for reactions (verifications, support etc).
2c The model is used as an interface, launching and controlling some resources, facilitating their manipulation and their procedural aggregation
2d In the case of cooperative use, the model can facilitate the participants' communication and coordination (floor-control, signaling, etc)
2e If it is semantically indexed, the model can provide retrieval, selection and alerting services, sustaining the run-time concretization of the components (matching role)
3 Meta- modeling. Observing (imagining) the primary process 1 of the model's editing (or the P-1-2-S chain of reproducing procedures with the model help), some process engineers can edit meta-models for explaining or supporting the modeling.
3b Observers, demonstrators or captors watching the edition process can generate metafunction pre-models.

4 Meta-reproduction. Using meta-functions (in the a,b,c,d,e sense), the primary process 1 of function editing can be reproduced (with variations) in secondary editing processes 1S- producing functions usable in the 2-S chain

3 Application suggestions

I telegraphically signal the interest of the "function" concept for:
KVS- active modeling; metamodeling of the model-reality physiology
IWL- combining procedures' support (guiding, ordering, coordinating) with the facilitation of their learning (from a pedagogical management of procedures to the management of pedagogical procedures)
AST- use of the semantic layer in the coordination of educational activities and reciprocally, the management of his evolution, piloted by these activities
I-Know'06- managing the global physiology of evolving knowledge based systems.

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Note: These texts detail the considerations presented above.

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