Enhancing the Conceptual Framework Capability for a Measurement and Evaluation Strategy

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Abstract. To provide consistency and repeatability for measurement and evaluation (M&E) projects and programs a well-established M&E strategy is needed. In a previous work, we have discussed the benefits of having an integrated M&E strategy that relies on three capabilities such as an M&E conceptual framework, process and method specifications. Besides, we have developed GOCAME (*Goal-Oriented Context-Aware Measurement and Evaluation*) as an integrated M&E strategy which supports these capabilities. In the present work, we enhance its former conceptual framework with the recently built process ontology, enriching also the M&E terms with stereotypes stemming from the process conceptual base. The augmented conceptual framework has also a positive impact on the other strategy capabilities since ensures terminological uniformity and testability to process and method specifications. For illustration purposes, excerpts of process specifications regarding the new situation are highlighted.

Keywords: Process Ontology, Quality, Measurement, Evaluation, GOCAME, C-INCAMI.

1 Introduction

Besides to establish a set of activities and procedures for specifying, collecting, storing, and using metrics (for a measurement task) and indicators (for an evaluation task) in a systematic way, we argue that more robust analysis and decision-making processes can be achieved if the following three capabilities of an M&E strategy are considered at once: i) a *M&E process specification*; ii) a *M&E conceptual framework*; and, iii) *method specifications*.

Firstly, to assure repeatability and reproducibility for M&E activities and also consistency of results, it is necessary to provide specifications of process (model) views, which prescribes or informs a set of activities, their inputs and outputs, roles, interdependencies, and so forth. The specification of these views can consider different process perspectives such as functional, informational, organizational, amongst others [1]. Secondly, a well-established M&E conceptual framework should be built upon a robust conceptual base, which explicitly and formally specifies the main agreed concepts, properties, relationships, and constraints. Lastly, clear specifications of methods (and tools) are necessary in order to the tasks can be

Q.Z. Sheng and J. Kjeldskov (Eds.): ICWE 2013 Workshops, LNCS 8295, pp. 104–116, 2013.

allotted and performed systematically. Furthermore, a M&E strategy that includes these three capabilities simultaneously is called an integrated strategy. The rationale for this is given in [2].

In this direction, we have built an integrated M&E strategy, named GOCAME (*Goal-Oriented Context-Aware Measurement and Evaluation*). This strategy supports the above three capabilities, namely: the C-INCAMI (*Contextual-Information Need*, *Concept model*, *Attribute*, *Metric* and *Indicator*) conceptual framework [3]; the M&E process specifications for the different views i.e. functional, organizational, behavioral and informational perspectives [4]; and the WebQEM (*Web Quality Evaluation*) methodology and its associated tool.

However, the M&E terms included in C-INCAMI do not allow identifying explicitly if, for example, a measurement is a task, a metric is a method or a measure an outcome, amongst other aspects. So there exists an opportunity to enrich semantically the GOCAME M&E conceptual framework with process terms, which represents an improvement from the conceptual framework capability standpoint.

The contributions of this work are: i) to develop a process conceptual base; ii) to enhance the former M&E (C-INCAMI) conceptual framework adding more semantic to its terms by linking them with the process conceptual base; iii) to improve the M&E process and method specifications giving them a greater semantic consistency. Additionally, we illustrate how the process concepts linked to the M&E concepts help to build better specifications for the process views and their testability.

The rest of this paper is organized as follows. Section 2 summarizes the GOCAME strategy and its three capabilities. Section 3 discusses the process ontology, the enhanced M&E conceptual framework and the impact of this improvement on the other capabilities. Section 4 analyzes state-of-the-art researches on M&E conceptual frameworks, particularly, those which are enhanced by a process conceptual base. Finally, Section 5 outlines the conclusions and future work.

2 GOCAME Overview

GOCAME is a multi-purpose M&E strategy which follows a goal-oriented and context-sensitive approach in defining M&E projects. It is based on the three capabilities mentioned above, which are summarized below.

GOCAME has its M&E terminological base defined as an ontology [5], from which the C-INCAMI conceptual framework emerges. The metric and indicator ontology provides a domain model that defines all the concepts, properties and relationships which in turn helps to design the M&E activities. This way, a common understanding of data and metadata is shared among the organization's projects lending to more consistent results and analysis across projects.

C-INCAMI is structured in six components, namely: i) M&E project component, which allows specifying the management data for *M&E projects*; ii) Nonfunctional requirements component, which allows specifying the *Information Need* for a given *purpose* and the *user viewpoint* related to an *Entity* and quality *focus*. The focus is represented by a *Concept Model* (e.g. a quality model) which includes *Calculable Concepts* (i.e. characteristics), *sub-concepts* (i.e. sub-characteristics) and associated

Attributes. Attributes are measurable properties of an entity under analysis; iii) Context component, which describes the relevant *Context* through *Context properties* which are attributes; iv) Measurement component, which allows specifying *Direct* and *Indirect Metrics* used by *Direct* and *Indirect Measurement* tasks which produce *Base* and *Derived Measures* respectively; v) Evaluation component, which allows specifying the evaluation task through *Indicators*, which interpret attributes and calculable concepts for a non-functional requirements tree. Two types of indicators are distinguished: *Elementary Indicators* which evaluate lower-level requirements (attributes), and, *Derived Indicators*, which evaluate higher-level requirements, i.e. sub-characteristics and characteristics; and vi) Analysis and Recommendation component, which supports data and information analysis in order to provide recommendations for improvement.

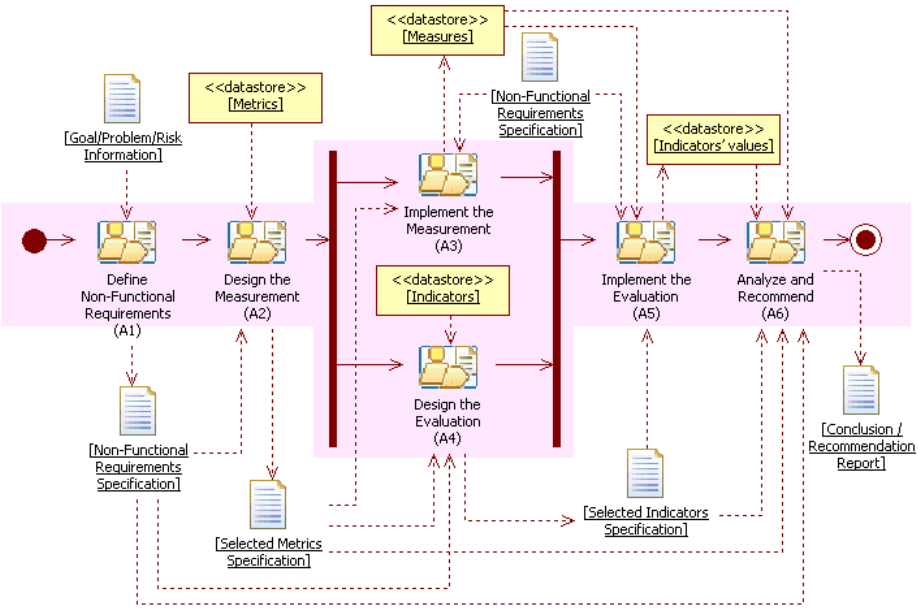

Fig. 1. The functional and behavioral process views of GOCAME

GOCAME has a well-defined M&E process specification [4], which is composed of six main activities as shown in Figure 1. These activities are: (A1) *Define Non-functional Requirements*; (A2) *Design the Measurement*; (A3) *Implement the Measurement*; (A4) *Design the Evaluation*; (A5) *Implement the Evaluation*; and (A6) *Analyze and Recommend*. The M&E process is specified in SPEM language [6]. Additionally, activities can be specified with a template that describes the activity name, objective, pre-conditions, post-conditions, inputs and output, roles, etc. We also observe in Figure 1 that concepts defined in the M&E terminological base are reused such as Metric, Measure and Indicator, amongst others.

Lastly, GOCAME is supported by the WebQEM methodology. This provides the 'how' to implement the requirements, measurement, evaluation, analysis and recommendation activities. It comprises a set of methods, techniques and tools to carry out the description of activities.

3 Updating GOCAME

Aimed at enhancing the GOCAME strategy, we recently developed a process ontology for enriching the terms of C-INCAMI conceptual framework. The terms from the process ontology are used as stereotypes in the C-INCAMI framework with the purpose of adding more semantic to the M&E domain concepts. The augmented conceptual framework has also a positive impact on the other strategy capabilities since ensures terminological uniformity to process and method specifications in addition to testability. Next, we summarize the process ontology and the enhanced M&E conceptual framework. Also, for illustration purposes, we show excerpts of process specifications regarding the new situation.

3.1 A Process Conceptual Base

In the process domain a lack of consensus regarding its terms and meaning is still an issue. For example, in some recent works [6, 7, 8] the *process*, *activity* and *task* terms, even though sharing the same syntax they do not share totally the same semantic. It happens the same with the *process element* term used both in [6] and [7]. On the other hand, there are documents which use other terminology such as in [9], where activities are called *complex activities*, and tasks *atomic activities*. Ultimately, in our process ontology the process/activity/task concepts are used, which are compliant with the meaning given in ISO 12207 [10]. Specifically, a process groups a set of activities and an activity groups a set of tasks, being a task an atomic element.

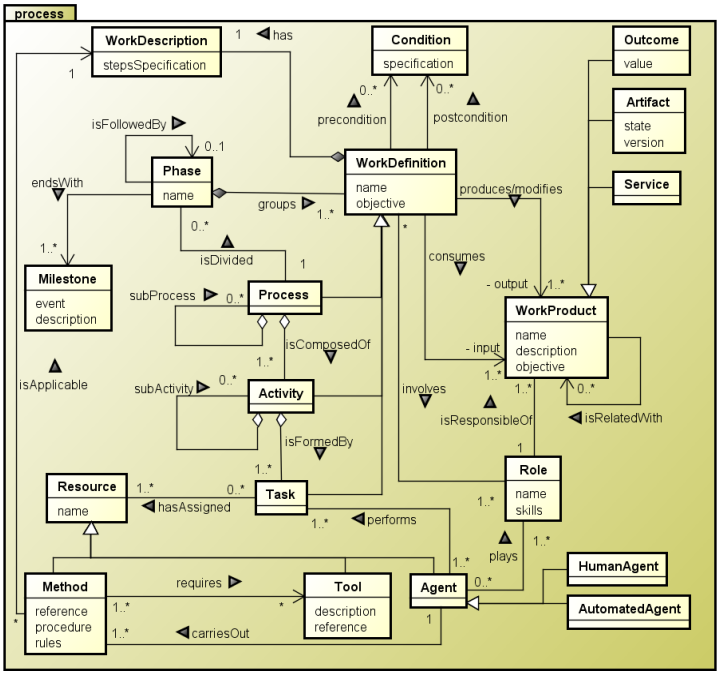

Fig. 2. Terms and relationships for the Process component

Table 1. Definition of Process terms, which are included in Figure 2

Process Term	Definition
Activity	It is a **Work Definition** that is formed by an interrelated set of sub-activities and **Tasks**. Note 1: A sub-activity is an **Activity** at a lower granularity level. Note 2: In engineering projects, while **Activities** are planned, **Tasks** are scheduled and enacted.
Agent	Performer assigned to a **Task** in compliance with a **Role**.
Artifact	It is a tangible or intangible, versionable **Work Product**, which can be delivered.
Automated Agent	It is an automated type agent.
Condition	Situation that must be achieved at the beginning (pre-condition) or ending (post-condition) of a **Work Definition** realization.
Human Agent	It is a human type agent.
Method	Specific and particular way to perform the specified steps in the description of a **Work Definition**. Note 1: The specific and particular way of a **Method** –i.e. *how* the described steps in a work definition should be made- is represented by a procedure and rules.
Milestone	A meaningful event. Note 1: A **Milestone** represents for instance a **Phase** finalization.
Outcome	It is an intangible, storable and processable **Work Product**.
Phase	A group of strongly-related **Work Definitions** defined in a given order. Note 1: A **Phase** ends with a **Milestone**. Note 2: In a phase the **Work Definitions** are **Processes** and/or **Activities**.
Process	It is a **Work Definition** that is composed of an interrelated set of sub-processes and activities. Note 1: A sub-process is a **Process** at a lower granularity level.
Resource	Asset assigned to perform a **Task**. Note 1: An asset is an entity with added value for an organization.
Role	A set of skills that ought to own an **Agent** to perform a **Work Definition**. Note 1: Skills include abilities, competencies and responsibilities.
Service	It is an intangible, non storable and deliverable **Work Product**.
Task	It is an atomic **Work Definition**, which cannot be decomposed. Note 1: Conversely to an **Activity** and **Process**, a **Resource** is assigned (scheduled) to a **Task**, e.g. **Resources** such as a **Method**, **Agent**, etc.
Tool	Instrument that facilitates the execution of a **Method**. Note 1: An instrument can be physical (hardware), computerized (software) or a mix of both types.
Work Definition	Abstract entity which describes the work by means of consumed and produced **Work Products**, **Conditions** and involved **Roles**. Note 1: Work represents a **Process**, an **Activity** or a **Task**.
Work Description	Specification of the steps for achieving the objective of a **Work Definition**. Note 1: The specification of the steps is a set of general actions –both **Activities** and **Tasks**- or a transformation function. It represents *what* should be done instead of *how* it should be performed. Note 2: The specification of the description of a **Work Definition** can be formal, semi-formal or informal as for example the natural language.
Work Product	A product that is consumed or produced by a **Work Definition**.

Due to the above mentioned issues, among others, we have built the process conceptual base as shown in Figure 2. It is important to remark that in 1997, we specified a process conceptual base [11], which had been based on seminal works such as [12] and [13], amongst others. The current process conceptual base is built on [11] considering also more recent contributions such as SPEM, CMMI and ISO 12207.

Figure 2 depicts the terms, relationships and main attributes included in our process component. Also in Table 1, the process ontology terms are defined. The definition of attributes and relations will be documented in a follow-up manuscript.

In our ontology, *Process*, *Activity* and *Task* are, at different abstraction levels specializations of *Work Definition*. For instance, a process is composed of sub-processes or activities, which in turn are formed by sub-activities or tasks. In Table 1, the task term is defined as "*an atomic Work Definition, which cannot be decomposed*". Additionally, a process can be divided into *Phases*.

A work definition *consumes* and *produces* one or more *Work Products*. Note that an *Outcome*, *Artifact* or *Service* are kinds of work products. In Table 1, the outcome term is defined as "*an intangible, storable and processable Work Product*", while artifact "*is a tangible or intangible, versionable Work Product, which can be delivered*". On the other hand, a work definition has a *Work Description*, which specifies the steps for achieving its *objective*. It represents 'what' should be done instead of 'how' it should be performed. The semantic of 'how' is represented by the *Method* term, i.e. the specific and particular way to perform the specified steps e.g. in a task. Note that a method concept has the *procedure* and *rules* attributes in Figure 2.

Lastly, taking into account that a task -unlike a process and activity- is scheduled and enacted it has therefore allocated *Resources* such as *Method*, *Tool* as well as an *Agent* that plays a *Role*. In Table 1, the resource term is defined as "*asset assigned to perform a Task*".

So, the above conceptual base is one of the contributions listed in the Introduction Section. This conceptual base contains the key concepts necessary to model and specify different process (model) views, while enriches semantically many M&E terms as we show below.

3.2 Enhancing the GOCAME Conceptual Framework Capability

The second contribution listed in the Introduction Section is to enhance the former M&E (C-INCAMI) conceptual framework adding more semantic to many of its terms. This is done by linking M&E terms with process terms by using UML stereotypes. A stereotype is an UML model element, which is an extensibility mechanism [14]. It is represented syntactically by means of small labels between « and » signs. Moreover stereotypes are applied to a diagram elements or relationships indicating additional meaning.

In our case, we have employed the process terms (Table 1) as stereotype labels for enriching many M&E terms. Figure 3 shows four out of six C-INCAMI components introduced in Section 2. So far, the *measurement* and *evaluation* components are

augmented with process terms and relationships. An example of an enriched term is *Metric*, which is stereotyped with «Method» from the process component.

Looking at Table 2, a metric is "*the defined measurement or calculation procedure and the scale*". Now, with the «Method» stereotype a metric also includes the semantic of a method, which is defined as the "*specific and particular way to perform the specified steps in the description of a Work Definition*". So a metric specifies *how* should be made the described steps (*what*) of a measurement task. Moreover, if we look at the *procedure* and *rule* attributes of the *Method* term (Figure 2), hence the *Direct/Indirect Metric* has accordingly a *Measurement/Calculation Procedure* and a *Scale* as a *rule*. This new situation is specified in Figure 3.

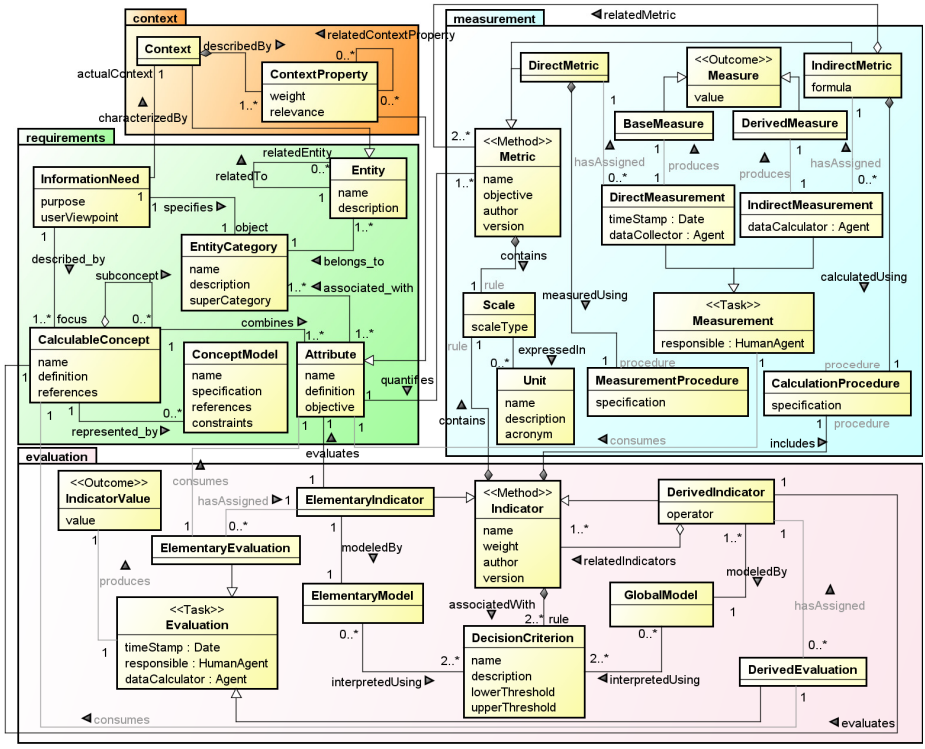

Fig. 3. Main concepts and relationships for C-INCAMI enriched with process stereotypes

It is important to remark that the abovementioned link between components has introduced minor changes in the definition of some *measurement* and *evaluation* terms with regard to previous definitions [3]. In addition, new terms have emerged such as for example *Direct Measurement/Base Measure* and *Indirect Measurement/ Derived Measure* in order to have a more terminological completeness and detail. All these adapted definitions and/or new terms in addition to the link with process terms are shown in Table 2.

Another enhancement has been made on relations among terms in Figure 3, which is aimed at increasing the consistency between M&E and process components. For instance, we added the *consumes* relationship between *Measurement* and *Attribute* terms. Thus a Measurement task *consumes* an Attribute (as input) and *produces* a Measure (as output). Note that the added and renamed relations are highlighted in gray.

3.3 Impact of the Enhanced Conceptual Framework on the Other Capabilities

As introduced in Section 1, besides the *conceptual framework capability*, there exists in GOCAME other two integrated capabilities, namely: the *M&E process specification capability*, and the *method specifications capability*.

Table 2. Definition of M&E terms, which are semantically enriched with process terms

M&E Term	Definition	Process Term
	Measurement Term	
Base Measure	A measure that does not depend upon other measure.	Outcome
Calculation Procedure	Set of established and ordered instructions of an indirect metric or indicator that indicates how the described steps in an indirect measurement or evaluation task should be carried out.	procedure in Method
Derived Measure	A measure that is derived from other measures.	Outcome
Direct Measurement	Measurement that produces a base measure.	Task
Direct Metric	A metric of an attribute that does not depend upon a metric of any other attribute	Method
Indirect Measurement	Measurement that produces a derived measure.	Task
Indirect Metric	A metric of an attribute that depends of metrics of other attributes.	Method
Measure	The number or category assigned to an attribute of an entity by making a measurement. Note 1: It is the measurement output that represents an outcome as work product.	Outcome
Measurement	A task that uses a metric in order to produce a measure's value. Note 1: This task quantifies an attribute by producing a measure as outcome.	Task
Measurement Procedure	Set of established and ordered instructions of a direct metric that indicates how the described steps in a direct measurement task should be carried out.	procedure in Method
Metric	The defined measurement or calculation procedure and the scale. Note 1: A metric is a method which is applicable to the description of a measurement task.	Method

Table 2. (*Continued.*)

Evaluation Term		
Derived Evaluation	Evaluation that produces an indicator's value by assessing a calculable concept.	Task
Derived Indicator	An indicator that is derived from other indicators to evaluate a calculable concept.	Method
Elementary Evaluation	Evaluation that produces an indicator's value by assessing an attribute. Note 1: An attribute is a non-functional elementary requirement from the evaluation standpoint.	Task
Elementary Indicator	An indicator that does not depend upon other indicators to evaluate an attribute.	Method
Evaluation	A task that uses an indicator in order to produce an indicator's value.	Task
Indicator	The defined calculation procedure and scale in addition to the indicator model and decision criteria in order to provide an evaluation of a calculable concept or attribute with respect to a defined information need. Note 1: An indicator is a method which is applicable to the description of an evaluation task.	Method
Indicator Value	The number or category assigned to a calculable concept or attribute by making an evaluation. Note 1: It is the evaluation output that represents an outcome as work product.	Outcome

The process specification capability embraces different process views such as functional, behavioral, informational and organizational. Figure 1 depicts the high-level process specification diagram for the GOCAME strategy stressing the functional and behavioral perspectives. Particularly, the functional view represents what activities/tasks should be performed in the M&E process as well as the inputs and outputs (work products) that will be consumed and produced, respectively. On the other hand, the behavioral view represents the dynamics of the process i.e., sequences, parallelisms, iterations, feedback loops, among other aspects. Note that, in Figure 1 the names of activities as well as work products make use of the M&E terminology like *Measurement*, *Evaluation*, *Metric*, *Measure*, etc. As a consequence, the use of the C-INCAMI conceptual base benefits the terminological uniformity in the specifications of process views. Moreover, the augmented C-INCAMI conceptual base with process terms as shown above has a positive impact on the M&E process and method specifications due to they provide a greater semantic consistency.

In order to demonstrate how the process terms linked to M&E terms allow building more consistent and testable process view specifications, an A3 sub-activity is described. This sub-activity is named *Quantify Attributes* and is depicted in Figure 4. It implies executing, iteratively, the Measurement task for each attribute from the requirements tree. (Recall that a requirements tree is made up of (sub-)characteristics and attributes instantiated from a quality model).

Looking at Figure 4 we can see that each Measurement task execution consumes an attribute and produces a measure, which is stored in the measures datastore. In order to perform the measurement for a given entity attribute the Data Collector must follow the (measurement or calculation) procedure and rules described in the (direct or indirect) Metric respectively. Each metric that quantifies each attribute was previously selected in the A2 activity (recall Figure 1), and added to the Selected Metrics Specification artifact.

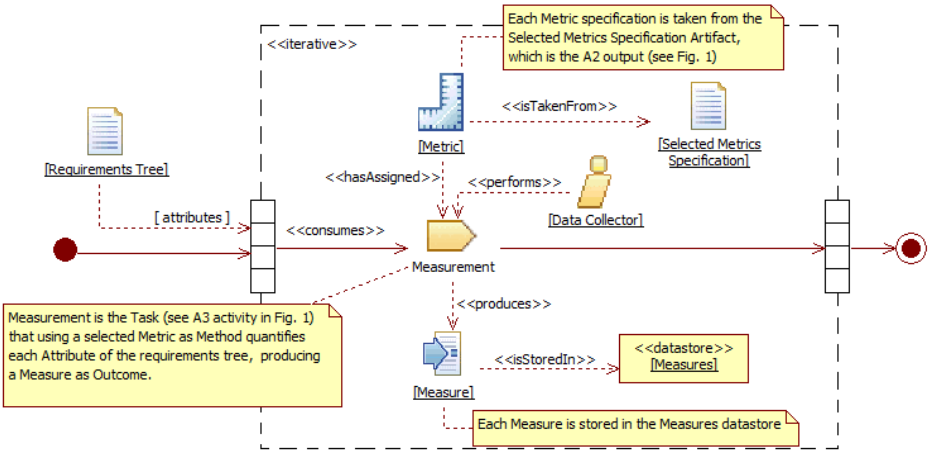

Fig. 4. SPEM diagram for the *Quantify Attributes* activity

Following with the terminological consistency analysis between the process specification and the augmented C-INCAMI conceptual base, we observe in Figure 4 that the task named Measurement consumes an attribute and produces a measure. This process specification is semantically consistent when tested against the C-INCAMI measurement component, since the *Measurement* term (enriched with the «Task» stereotype in Figure 3) is associated to the *Attribute* term with the *consumes* relationship, and to the *Measure* term with the *produces* relationship. Also in Figure 4 the produced measure which is modeled as an outcome is consistent with the *Measure* term in Figure 3, which in turn is enriched with the «Outcome» stereotype from the process conceptual base.

Also, we observe in Figure 4 that the Measurement task *has assigned* a metric as a resource. This is consistent with the augmented M&E conceptual base since the *Measurement* term (i.e. its specialization, either direct or indirect measurement) is related to the *Metric* term (i.e. its specialization, either direct or indirect metric) by the *hasAssigned* relationship. Lastly, the *Metric* term has also the semantic of the Method term in Figure 3, and a *Method* is a *Resource* for the task, regarding the process conceptual base in Fig. 2. In the end, the *hasAssigned* relationship of Fig. 4 is semantically consistent with that in figures 2 and 3.

Finally, the augmented C-INCAMI capability impacts positively on the terminological consistency and testability for the method specification capability. For

instance, a metric has the semantic of a method as discussed above, so we can check that a metric template contains all the metadata such as the (measurement or calculation) procedure and its associated rules such as scale. Likewise for indicator specifications. Ultimately, a metric/indicator specifies *how* should be carried out the *what*, i.e. the described steps of a measurement/evaluation task.

4 Related Work and Discussion

An M&E strategy is considered in [2] as integrated if the definitions of process and method specifications make use of a common M&E conceptual base. Particularly in the GOCAME strategy, the process and method specifications use the terms defined in the M&E conceptual framework so-called C-INCAMI. However, by looking at the C-INCAMI terms we cannot clearly identify which process concepts are represented in the M&E domain. Hence, we observed an opportunity for improvement by adding semantic to the former M&E conceptual base using our presented process conceptual base. One impact of this enhancement is that process and method specifications can now be tested for additional semantic consistency.

Regarding the above issue, a related work that focuses on specifying a software quality ontology is in [15]. This quality ontology is based on UFO (*Unified Foundational Ontology*) [16]. Additionally, they developed SPO (*Software Process Ontology*) [9], which is also based on UFO and related with the quality ontology. The quality ontology is divided into three sub-ontologies, namely: quality models, measurement, and evaluation. The quality ontology based on UFO can provide, as indicated by authors, robustness but also can generate some semantic inconsistencies. A clear example of this inconsistency can be seen in the following situation: in the SPO version documented in [16], authors show that *hardware resource*, *software resource* and *human resource* inherit from *resource*; however, in [9] a *human resource* is not a *resource*. This happened since a *resource* represented in SPO is in UFO an *object*, and given that a *human resource* cannot be an *object* from the semantic standpoint, then they decided to remove such a link.

On the other hand, SPO uses terminology which to some extent differs from recognized standards in the process area such as SPEM [6], CMMI [7] and ISO [10]. For example, instead of using the *work product* term authors use *artefact*, not doing distinction with *outcome* and *service* terms. Also they do not use the *task* term but rather the *atomic activity* term, as commented in sub-section 3.1.

Regarding the measurement sub-ontology [15], we observe an ambiguity in using the *measure* term, since sometimes it refers to the value produced by a measurement, while sometimes to the instrument (procedure) for obtaining such a value. This duality of the *measure* term is also observed in [7, 17, 18]. Instead, we make a clear distinction between *measure* and *metric* terms, linking them also to our process ontology -as discussed in sub-section 3.3. Besides to refer to properties of an entity authors use the *measurable element* concept [15]; however, the widely used concept in the M&E literature is *attribute* [17, 18, 19]. Lastly, they do not include context terms as we did in the context component [20].

Finally, SPEM focuses on defining a generic framework for process modeling. Although SPEM was not intended to model concepts for the M&E domain it was a valuable consultation source for developing our process ontology and process view specifications. Another related work is FMESP (*Framework for the Modeling and Evaluation of Software Processes*) [21]. This framework has two ontologies, vis. the software process modeling ontology, and the software measurement ontology. However, so far we have not found any public paper of FMESP, which explicitly relate both ontologies as we did.

5 Conclusion and Future Work

In a previous research, we have developed an integrated M&E strategy so-called GOCAME which relies on three capabilities: C-INCAMI conceptual framework, M&E process view specifications, and method specifications.

In the present work, we have discussed the semantic enhancement of the C-INCAMI conceptual framework capability, by relating it with the process ontology terms. The building of the process conceptual base is one of the stated contributions in the Introduction Section. Moreover, we have enriched the M&E terms with process terms by means of UML stereotypes. Finally, we have illustrated how the augmented C-INCAMI capability impacts positively on the terminological consistency and testability for the method and process view specification capabilities.

As a future line of research we plan to enhance the M&E conceptual framework by adding terms for the Analysis and Recommendations component. Likewise we made in [2], after all these changes be performed the GOCAME improvement gain will be re-evaluated.

Acknowledgments. Thanks to the support given from the Science and Technology Agency, Argentina, in the PAE-PICT 2188 project, and in the 09-F047 project at UNLPam, Argentina.

References

1. Curtis, B., Kellner, M., Over, J.: Process Modelling. Com. of ACM 35(9), 75–90 (1992)
2. Papa, F.: Toward the Improvement of a Measurement and Evaluation Strategy from a Comparative Study. In: Grossniklaus, M., Wimmer, M. (eds.) ICWE 2012 Workshops. LNCS, vol. 7703, pp. 189–203. Springer, Heidelberg (2012)
3. Olsina, L., Papa, F., Molina, H.: How to Measure and Evaluate Web Applications in a Consistent Way. In: Rossi, Pastor, Schwabe, Olsina (eds.) Springer HCIS Book Web Engineering: Modeling and Implementing Web Applications, pp. 385–420 (2008)
4. Becker, P., Lew, P., Olsina, L.: Specifying Process Views for a Measurement, Evaluation and Improvement Strategy. Advances in Software Engineering, Software Quality Assurance Methodologies and Techniques 2012, 1–27 (2012)
5. Olsina, L., Martin, M.: Ontology for Software Metrics and Indicators. Journal of Web Engineering 2(4), 262–281 (2004)

6. OMG-SPEM: Software & Systems Process Engineering Meta-Model Specification V2.0 (2008)
7. CMMI Product Team: CMMI for Development, Ver. 1.3 (CMU/SEI-2010-TR-033). The Software Engineering Institute, Carnegie Mellon University website (2010), http://www.sei.cmu.edu/library/abstracts/reports/10tr033.cfm (retrieved February 06, 2013)
8. ISO/IEC 15504-5: Information technology - Process assessment - Part 5: An exemplar software life cycle process assessment model (2012)
9. Bringuente, A., Falbo, R., Guizzardi, G.: Using a Foundational Ontology for Reengineering a Software Process Ontology. Journal of Information and Data Management 2, 511–526 (2011)
10. ISO/IEC 12207: Systems and software engineering - Software life cycle processes (2008)
11. Olsina, L.: Functional View of the Hypermedia Process Model. In: The Fifth International Workshop on Engineering Hypertext Functionality at International Conference on Software Engineering (ICSE 1998), Kyoto, Japan, pp. 1–10 (1998)
12. Feiler, P.H., Humphrey, W.S.: Software Process Development and Enactment: Concepts and Definitions. In: International Conference of Software Process (ICSP), pp. 28–40. IEEE Computer Society, Berlin (1993)
13. Lonchamp, J.: A Structured Conceptual and Terminological Framework for Software Process Engineering. In: International Conference on the Software Process (ICSP), pp. 41–53. IEEE Computer Society Press, Berlin (1993)
14. OMG-UML: Unified Modeling Language, Superstructure, v2.3 (2010)
15. Barcellos, M.P., Falbo, R., Dal Moro, R.: A Well-Founded Software Measurement Ontology. In: Galton, A., Mizoguchi, R. (eds.) Proceedings of the Sixth International Conference FOIS 2010, pp. 213–226. IOS Press, Amsterdam (2010)
16. Guizzardi, G., Falbo, R., Guizzardi, R.: Grounding Software Domain Ontologies in the Unified Foundational Ontology (UFO): The case of the ODE Software Process Ontology. In: Proceedings de la XI Conferencia Iberoamericana de Software Engineering (CIbSE 2008), pp. 127–140 (2008)
17. ISO/IEC 15939: Software Engineering - Software Measurement Process (2002)
18. ISO/IEC 25000: Software Engineering - Software product Quality Requirements and Evaluation (SQuaRE) - Guide to SQuaRE (2005)
19. ISO/IEC 14598-5: IT - Software product evaluation - Part 5: Process for evaluators (1998)
20. Molina, H., Olsina, L.: Assessing Web Applications Consistently: A Context Information Approach. In: 8th Int'l Congress on Web Engineering, NY, US, pp. 224–230. IEEE CS (2008)
21. García, F., Piattini, M., Ruiz, F., Canfora, G., Visaggio, C.A.: FMESP: Framework for the modeling and evaluation of software processes. Journal of Systems Architecture 52(11), 627–639 (2006)