

Relaxing Modeling Criteria to Produce Genuinely Flexible, Controllable, and Usable Enterprise Modeling Methods

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Abstract: Enterprise modeling (EM) applies abstraction in creating simplified representations of complex realities. Unfortunately, both the realities and the task of creating valid conceptual representations bring daunting challenges. Complexity is increasing, e.g. the transition of conventional production towards product-service systems operating in heterogeneous enterprise ecosystems. Simultaneously, modeling methods and tools tend to be formal and inflexible, and often are designed for automated model processing rather than for helping business professionals understand business situations. The result is the current, unsatisfying state of enterprise modeling, in which models can be developed and used directly only by modeling experts and are largely impenetrable to non-experts. This paper presents a set of principles that suggest directions for progress toward genuinely flexible, controllable, and usable enterprise models. The principles accept the relaxation of some expectations about enterprise modeling while trying to maintain rigor and completeness in models.

Keywords: Enterprise Modeling; Modeling Principles; Modeling Methods

1 Mismatch between Modeling Capabilities and Modeling Goals

Attention to rigor and completeness is a central tenet of systems analysis and design (SA&D), requirements engineering, enterprise modeling, and conceptual modeling in general. For example, Bork and Fill [BF14, p. 3400] speak of representing “static and dynamic phenomena of systems prior to their implementation,” which typically requires formal models that are precise and complete. A long term vision of translating directly and automatically from conceptual models and requirements specifications to executable code has driven passionate IS research debates focusing on the completeness and general adequacy of ontologies, metamodels, and reference models.

The benefits of enterprise models often come at the cost of complexity and inflexibility due to formalization and rigor needs of modeling methods and supporting tools. In contrast, domain experts often perceive the business in imprecise ways and may or may not have the expertise to capture their knowledge in a conceptual model. Furthermore, modeling tools sometimes constrain intuitive specification of externalized knowledge by forcing users to express themselves in modeling languages that are unfamiliar or difficult to use.

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A position paper by Sandkuhl et al. [Sa18] encourages transforming EM from an elite discipline performed by experts towards a vision of "modeling for the masses". An important element of their future research agenda is *Softened Requirements to Completeness, Coherence and Rigor*. This paper builds on that goal by proposing a set of principles that might be incorporated in an EM approach for creating genuinely flexible, controllable, and usable models. Application of those principles probably would require softening some criteria for model quality that the EM community takes for granted. The question at hand is whether the proposed principles would generate desired benefits without sacrificing important values and goals of the EM community.

2 Principles for Relaxed Enterprise Modeling

Our proposed EM principles aim at a compromise between important but divergent approaches to EM. Emphasizing rigor and correctness of models and modeling methods, Karagiannis and Kühn [KK02] say that the foundations of formal modeling include the modeling language (comprising its semantics, syntax, and notation), modeling procedure, and mechanisms & algorithms. In contrast, Sandkuhl et al. [Sa18] argue for democratizing EM and seem willing to accomplish that through approaches such as consolidating semi-formal models produced by business professionals. This paper's compromise between those two directions maintains the idea of rigorous modeling but proposes principles that relax or even omit some built-in assumptions of current EM methods. We may find that most principles can co-exist while some of them prove mutually contradictory in practice.

Tab. 1: Principles for Relaxed Enterprise Modeling

Principle	Rationale
Abstraction	Models are abstractions of other things and therefore are not equivalent to those things. The structure and behavior of a model is not equivalent to the structure and behavior of whatever is being modeled. Increasing the level of detail and precision in a model will not generate something that is equivalent to whatever is being modeled.
Priorities	Details of models should be driven by the content being represented and the purposes of the model's users. Details of models should not be driven by a need to satisfy the requirements of a modeling technique or metamodel or by the expectations or preferences of the EM community.
Usability Principles	
Controllability	Users should be able to control a model and view it from different perspectives and at different levels of detail. Different users might have quite different goals ranging from attaining a basic understanding of a business situation through using simulation or other automated methods to predict how a system will behave.

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Principle	Rationale
Zoomability	As with online maps, it should be possible to visualize and explore the entire system under study and any part of it by changing the focus and level of detail, e.g., from highly aggregated to highly detailed. Using different zoom levels to slide between different levels of detail enables interactive exploration of models.
Cognitive manageability	Modeling methods, notations, and tools should not impose extraneous cognitive load [Sw94]. Modeling tools should help modelers focus on the content that they are concerned with and should minimize additional attention required to understand or use tools or notations for representing and displaying that content.
Content Principles	
Minimum critical specification	One of Cherns' [Ch87] sociotechnical principles says that designers and modelers should specify only what is necessary and should not specify unnecessary details. In a broader sense, over-specification is futile because the frequent occurrence of noncompliance and workarounds [A114].
Design incompleteness	Another of Cherns' sociotechnical principles says that the design of a sociotechnical system is always incomplete because sociotechnical systems (including processes, participants, goals, etc.) typically adapt in response to changes in the environment that surrounds it.
Completeness linked to purpose	Simulation and code generation require complete models. Incomplete models are adequate for representing vague or incomplete information [GP18], or for supporting communication among stakeholders.
Precision linked to purpose	Some aspects of a model or modeling language can be very precise while other aspects can be relatively vague. E.g., an imprecise model of a business process may be useful before filling in all intermediate events and task types.
Modeling Principles	
Domain specificity	A model's domain should be specified clearly. The domain of many models is somewhat unclear. For example, some models do not include the characteristics of human participants who produce a system's output.
Semantic clarity	Concepts in a model or modeling language should be defined clearly. That might seem obvious until one looks at models of service in which the concept of 'service' itself is not defined clearly.
Adaptable syntax	In contrast to established beliefs, it is possible for a model to be useful even if it does not have a formal syntax. In co-evolutionary contexts, syntactic concepts can be defined while modeling [CA13, WSG17].
Flexible notation	In certain scenarios, it is important for modelers to introduce specific notations while modeling [Bu18].

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Principle	Rationale
Imprecise semantics	Imprecision is almost inevitable when typical domain experts create conceptual models. Models should not try to be more precise than domain experts' imprecise knowledge about the system under study [GP18].
Flexible modeling procedures	It is possible to produce useful models without using a structured modeling procedure. Just as one might fill out a jigsaw puzzle by moving from the outside toward the center, it might also be possible to fill out the puzzle from the center to the outside.
Flexible Tooling	Controlled flexibility should be reflected in modeling tools, which should adapt to a user's objectives. Rigorously specified fixed metamodels and metamodel constraints are needed in some cases. In other cases, modelers' creativity and intuitions call for bypassing or augmenting fixed structures.
Modularity	Models should consist of modules whose interactions and internal elements can be named and described separately. Modularity makes it easier to describe the structure of a model and to set up the structure of a model before filling in the details.
Module-specific semantics	In a modular structure, concepts that are relevant to one module might not be relevant to another module. Therefore it should be possible for different modules to have different semantics.
Module-specific syntax	In a modular structure, any syntax that might be relevant to one module might not be relevant to another module. Therefore it should be possible for different modules to be modeled using different syntax.
Optional transparency	Modules are encapsulated but visibility to other modules or to users is optional, and ranges from glass box to black box.

3 Concluding Remarks

Research in conceptual modeling and EM focuses primarily on the precise and unambiguous representation of all relevant aspects of a system under study. Construction of these models is supported by modeling tools and methods that are not well suited to be used by domain experts and other stakeholders who lack modeling expertise. Thus, despite the wide adoption of EM and its strong contribution to the analysis and design of complex systems, its rigor and formality present obstacles to theory-driven and creativity-employing techniques of the IS discipline.

Each principle proposed by this paper presents a research challenge along a path toward enabling people who are not EM experts to participate fully in EM. Each principle can be used in describing or evaluating existing EM methods and in thinking about new EM methods, especially methods that might apply IS theories such as work system theory or

design thinking. Those and other practical approaches bring some degree of rigor while calling for relaxation of modeling constraints related to syntax, semantics, and notation that are built into existing EM methods and tools.

We intend to investigate practicalities of these principles in future research. We hope to focus special attention on tool-related implications of these principles within an overarching goal of maintaining a reasonable degree of rigor and formality while also allowing domain experts and other stakeholders to participate more fully in enterprise modeling.

References

- [Al14] Alter, Steven: Theory of Workarounds. *Communications of the Association for Information Systems*, 34(55):1041–1066, 2014.
- [BF14] Bork, Domenik; Fill, Hans-Georg: Formal Aspects of Enterprise Modeling Methods: A Comparison Framework. In: *System Sciences (HICSS)*, 2014 47th Hawaii International Conference on. IEEE, pp. 3400–3409, 2014.
- [Bu18] Butting, Arvid; Eikermann, Robert; Kautz, Oliver; Rumpe, Bernhard; Wortmann, Andreas: Controlled and Extensible Variability of Concrete and Abstract Syntax with Independent Language Features. In: *Proceedings of the 12th International Workshop on Variability Modelling of Software-Intensive Systems*. ACM, pp. 75–82, 2018.
- [CA13] Correia, Filipe Figueiredo; Aguiar, Ademar: Patterns of flexible modeling tools. In: *Proceedings of the 20th Conference on Pattern Languages of Programs*. The Hillside Group, pp. 1–9, 2013.
- [Ch87] Cherns, Albert: Principles of Sociotechnical Design Revisted. *Human relations*, 40(3):153–161, 1987.
- [GP18] Gonzalez-Perez, Cesar: Vagueness. In: *Information Modelling for Archaeology and Anthropology: Software Engineering Principles for Cultural Heritage*. Springer International Publishing, Cham, pp. 129–141, 2018.
- [KK02] Karagiannis, Dimitris; Kühn, Harald: Metamodelling Platforms. In: *E-Commerce and Web Technologies, Third International Conference, EC-Web 2002, Aix-en-Provence, France, September 2-6, 2002, Proceedings*. p. 182, 2002.
- [Sa18] Sandkuhl, Kurt; Fill, Hans-Georg; Hoppenbrouwers, Stijn; Krogstie, John; Matthes, Florian; Opdahl, Andreas; Schwabe, Gerhard; Uludag, Ömer; Winter, Robert: From Expert Discipline to Common Practice: A Vision and Research Agenda for Extending the Reach of Enterprise Modeling. *Business & Information Systems Engineering*, 60(1):69–80, 2018.
- [Sw94] Sweller, John: Cognitive load theory, learning difficulty, and instructional design. *Learning and instruction*, 4(4):295–312, 1994.
- [WSG17] Wüest, Dustin; Seyff, Norbert; Glinz, Martin: FlexiSketch: a lightweight sketching and metamodeling approach for end-users. *Software & Systems Modeling*, pp. 1–29, 2017.