

# Publications on Archetypes

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## PhD Theses and other Dissertations about *openEHR* Archetypes

- ***Semantic Mapping Of Clinical Model Data To Biomedical Terminologies To Facilitate Interoperability*** (PDF<sup>1</sup>)
    - **Rahil Qamar**  
Submitted to the University of Manchester for the degree of Doctor of Philosophy in the Faculty of Engineering and Physical Sciences, Mar 2008  
Supervisor: Prof Alan Rector
    - **Abstract:** The thesis presents and evaluates, the Model Standardisation using Terminology Systems (MoST) methodology, for integrating the clinical content in data models and terminology models. The MoST system developed for the purpose, aims to find semantically equivalent SNOMED terminology codes to map to archetype data model fragments. The two key stages of MoST include, (i) term finding, and (ii) data mapping. While the term finding procedure is completely automated, the data mapping procedure is assisted by clinical experts. The research recognises the significance of human intervention in ensuring the quality of the terminology codes being mapped to the data model fragments. Ensuring the quality of the mappings, helps maintain accuracy and unambiguity of coded data. The evaluation of the MoST system shows the importance of incorporating linguistic and semantic procedures, in addition to lexical lookups, to increase the chances of finding semantic matches. A significant contribution of the thesis is the description of the issues with current Archetype and SNOMED models with regards to the information needed to achieve effective model integration at content level. These issues were highlighted by the qualitative analysis of the evaluation. The issues point to semantic gaps in both the data and terminology models, which inhibit automated systems, such as MoST, from making intelligent inferences on the semantic appropriateness of the content. Suggestions for resolving these issues are detailed, where appropriate. A final contribution of the thesis is the set of guidelines that are suggested to the two modeling (Archetype and SNOMED) communities, to improve the quality of their model content. The hypothesis is that an increase in the content compatibility of the two models will increase the likelihood of the overall integration of the models, to achieve interoperability
  - ***Archetype based Domain Modelling for Health Information Systems*** (PDF<sup>2</sup>)
    - **Koray Atala#**  
Submitted to Department of Information Systems, Middle East Technical University (METU), July 2007  
Supervisor: Prof. Dr. Semih Bilgen
    - **Abstract:** A major problem to be solved in health informatics is high quality, structured and timely data collection. Standard terminologies and uniform domain conceptual models are important steps to alleviate this problem which are also proposed to enable interoperability among systems. With the aim of contributing to the solution of this problem, this study proposes novel features for the Archetypes and multi-level modeling technique in health information and knowledge modeling. The study consists of the development of a research prototype for endoscopic data management, and based on that experience, the extension of Minimal Standard Terminology in Digestive Endoscopy (MST). A major contribution of the study consists of significant extensions to the modeling formalism. The proposed modeling approach may be used in the design and development of health information systems based on archetypes for structured data collection, validation and dynamic user interface creation. The thesis work is aimed to make considerable contribution to the emerging Electronic Health Records (EHR) standards and specifications.
1. [http://www.openehr.org/publications/archetypes/RahilQamar-THESIS\\_Final.pdf](http://www.openehr.org/publications/archetypes/RahilQamar-THESIS_Final.pdf)
  2. [http://www.openehr.org/publications/archetypes/KorayAtalag-THESIS\\_Final.pdf](http://www.openehr.org/publications/archetypes/KorayAtalag-THESIS_Final.pdf)

## Papers Specifically about *openEHR/CEN* Archetypes

### Querying

- ***EHR Query Language (EQL) – a query language for archetype-based health records.*** (PDF<sup>3</sup>)
  - Chunlan Ma (a), Heath Frankel (a), Thomas Beale (a), Sam Heard (a)  
(a) Ocean Informatics
  - pp 397-401 Proceedings of MedInfo 2007, K. Kuhn et al. (Eds), IOS publishing, 2007.
  - **Abstract:** OpenEHR specifications have been developed to standardise the representation of an international electronic health record (EHR). The language used for querying EHR data is not as yet part of the specification. To fill in this gap, Ocean Informatics has developed a query language currently known as EHR Query Language (EQL), a declarative language supporting queries on EHR data. EQL is neutral to EHR systems, programming languages and system environments and depends only on the openEHR archetype model and semantics. Thus, in principle, EQL can be used in any archetype-based computational context. In the EHR context described here, particular queries mention concepts from the openEHR EHR Reference Model (RM). EQL can be used as a common query language for disparate archetype-based applications. The use of a common RM, archetypes, and a companion query language, such as EQL, semantic interoperability of EHR information is much closer. This paper introduces the EQL syntax and provides example clinical queries to illustrate the syntax. Finally, current implementations and future directions are outlined.

### Archetypes, Semantic Integration and Ontology

- ***Combining OpenEHR archetype definitions with SWRL rules – a translation approach.***
    - Lezcano, L., Sicilia, M.A. and Serrano-Balazote, P.
    - In Proceedings of the First World Summit on the Knowledge Society (WSKS'08), Springer Lecture Notes in Artificial Intelligence, 52880, pp. 80-89.
    - **Abstract:**  
The interoperability of electronic healthcare information systems is critical for a more effective healthcare management. Several specifications and standards have been created for facilitating such interoperability at different levels. Among them, the OpenEHR initiative emphasizes the sharing of flexible specifications of healthcare information pieces in the form of archetypes. However, the OpenEHR ADL language does not provide support for rules and inference which are important pieces of clinical knowledge. This paper reports on an approach to convert ADL definitions to OWL and then attach rules to the semantic version of the archetypes. This allows for an automated means to reuse knowledge expressed in the form of rules which is also flexible and follows the same philosophy of sharing archetypes.
  - ***Expressing Clinical Data Sets with openEHR Archetypes: A Solid Basis for Ubiquitous Computing.*** (IJMI link<sup>4</sup>)
    - Garde S, Hovenga E, Buck J, Knaup P
    - *International Journal of Medical Informatics.* 76 (S3): S334-S341.
    - **Abstract:**  
*Purpose:* The purpose of this paper is to analyse the feasibility and usefulness of expressing clinical data sets (CDSs) as *openEHR* archetypes. For this, we present an approach to transform CDS into archetypes, and outline typical problems with CDS and analyse whether some of these problems can be overcome by the use of archetypes.
3. [http://www.openehr.org/publications/archetypes/MedInfo\\_2007\\_EQL\\_MA.pdf](http://www.openehr.org/publications/archetypes/MedInfo_2007_EQL_MA.pdf)
4. <http://problems.can.be.overcome.2007.f2e004>

*Methods:* Literature review and analysis of a selection of existing Australian, German, other European and international CDSs; transfer of a CDS for Paediatric Oncology into *openEHR* archetypes; implementation of CDSs in application systems.

*Results:* To explore the feasibility of expressing CDS as archetypes an approach to transform existing CDSs into archetypes is presented in this paper. In case of the Paediatric Oncology CDS (which consists of 260 data items) this led to the definition of 48 *openEHR* archetypes. To analyse the usefulness of expressing CDS as archetypes, we identified nine problems with CDS that currently remain unsolved without a common model underpinning the CDS. Typical problems include incompatible basic data types and overlapping and incompatible definitions of clinical content. A solution to most of these problems based on *openEHR* archetypes is motivated. With regard to integrity constraints, further research is required.

*Conclusions:* While *openEHR* cannot overcome all barriers to Ubiquitous Computing, it can provide the common basis for ubiquitous presence of meaningful and computer-processable knowledge and information, which we believe is a basic requirement for Ubiquitous Computing. Expressing CDSs as *openEHR* archetypes is feasible and advantageous as it fosters semantic interoperability, supports ubiquitous computing, and helps to develop archetypes that are arguably of better quality than the original CDS.

• ***Semantic Issues in Integrating Data from Different Models to Achieve Data Interoperability*** (PDF<sup>5</sup>)

- Rahil Qamar (a), Alan Rector (a)  
(a) Medical Informatics Group, University of Manchester, Manchester, U.K.
- pp 674-678 Proceedings of MedInfo 2007, K. Kuhn et al. (Eds), IOS publishing, 2007.
- *Abstract:* Matching clinical data to codes in controlled terminologies is the first step towards achieving standardisation of data for safe and accurate data interoperability. The MoST automated system was used to generate a list of candidate SNOMED CT code mappings. The paper discusses the semantic issues which arose when generating lexical and semantic matches of terms from the archetype model to relevant SNOMED codes. It also discusses some of the solutions that were developed to address the issues. The aim of the paper is to highlight the need to be flexible when integrating data from two separate models. However, the paper also stresses that the context and semantics of the data in either model should be taken into consideration at all times to increase the chances of true positives and reduce the occurrence of false negatives.

• ***Framework for Clinical Data Standardization Based on Archetypes*** (PDF<sup>6</sup>)

- Jose A. Maldonado (a), David Moner (a), Diego Tomás (a), Carlos Ángulo (a), Montserrat Robles (a), Jesualdo T. Fernández (b)  
a Biomedical Informatics Group, ITACA Institute, Technical University of Valencia, Spain  
b Departamento de Informática y Sistemas, University of Murcia, Spain
- pp 454-458 Proceedings of MedInfo 2007, K. Kuhn et al. (Eds), IOS Press, 2007
- *Abstract:* Standardization of data is a prerequisite to achieve semantic interoperability in any domain. This is even more important in the healthcare sector where the need for exchanging health related data among professional and institutions is not an exception but the rule. Currently, there are several international organizations working on the definition of electronic health record architectures, some of them based on a dual-model approach. We present both an archetype modeling framework and LinkEHR-ED, an archetype editor and mapping tool for transforming existing electronic healthcare data which do not conform to a particular electronic healthcare record architecture into compliant electronic health records extracts. In particular, archetypes in LinkEHR-ED are formal representations of clinical concepts built on a particular reference model but enriched with mapping information to data sources which define how to extract and transform existing data in order to generate standardized XML documents.

5. [http://www.openehr.org/publications/archetypes/Medinfo\\_2007\\_QamarRector.pdf](http://www.openehr.org/publications/archetypes/Medinfo_2007_QamarRector.pdf)

6. ***Exploiting an XML registry semantic constructs for handling archetype metadata in healthcare***

informatics. (PDF<sup>7</sup>)

- Dogac, A., Laleci, G.B., Kabak, Y., Unal, S., Beale, T., Heard, S., Elkin, P.L., Najmi, F., Mattocks, C., Weber, D. and Kernberg, M. (2006).
- Int. J. Metadata, Semantics and Ontologies, Vol. 1, No. 1, pp.21–36.
- **Archetype-Based Semantic Integration and Standardization of Clinical Data.**
  - Moner, D. Maldonado, J.A. Bosca, D. Fernandez, J.T. Angulo, C. Crespo, P. Vivancos, P.J. Robles, M.
  - In: [Engineering in Medicine and Biology Society, 2006. EMBS '06. 28th Annual International Conference of the IEEE](#)<sup>8</sup>. Aug. 2006. pp 5141-5144.
- **Integration of Tools for Binding Archetypes to SNOMED CT.** (PDF<sup>9</sup>)
  - Erik Sundvall, Rahil Qamar, Mikael Nyström, Mattias Forss, Håkan Petersson, Hans Åhlfeldt, Alan Rector.
  - Semantic Mining Conference 2006.

## Archetypes and Governance

- **Towards Semantic Interoperability for Electronic Health Records: Domain Knowledge Governance for openEHR Archetypes.** (PDF<sup>10</sup>)
  - Garde S, Knaup P, Hovenga EJS, Heard S (2007).
  - Methods of Information in Medicine. 46(3): 332-343. (doi:10.1160/ME5001)..
- **Nursing Constraint Models for Electronic Health Records: a vision for domain knowledge governance.** (PDF<sup>11</sup>)
  - Hovenga E, Garde S, Heard S (2005).
  - Int J Med Inform . 74(11-12): pp886-898.

## Archetypes in Use

- **Importing Clinical Data into Electronic Health Records - Lessons Learnt from the First Australian GEHR Trials.** (PDF<sup>12</sup>)
  - Bird L, Goodchild A, Heard S.
  - Proceedings HIC 2002 conference.
- **Experiences with a Two-Level Modelling Approach to Electronic Health Records.** (PDF<sup>13</sup>)
  - L. Bird, A. Goodchild, Z. Tun.
  - Journal of Research and Practice in Information Technology 35 (2003).

7. [http://www.openehr.org/publications/archetypes/IJMSO\\_dogac\\_et\\_al\\_2006.pdf](http://www.openehr.org/publications/archetypes/IJMSO_dogac_et_al_2006.pdf)

8. <http://ieeexplore.ieee.org/xpl/RecentCon.jsp?punumber=4028925>

9. <http://www.hiww.org/smcs2006/proceedings/12SundvallSMCS2006final.pdf>

10. **Templates and Archetypes: how do we know what we are talking about?** (PDF<sup>14</sup>)  
[http://healthinformatics.cqu.edu.au/downloads/Garde\\_openEHR\\_Methods\\_2007.pdf](http://healthinformatics.cqu.edu.au/downloads/Garde_openEHR_Methods_2007.pdf)

11. <http://dx.doi.org/10.1016/j.jimedinf.2005.07.013>

12. [http://www.openehr.org/publications/archetypes/HIC2002\\_bird\\_goodchild\\_heard.pdf](http://www.openehr.org/publications/archetypes/HIC2002_bird_goodchild_heard.pdf)

13. **Archetypes: Constraint-based domain models for future-proof information systems.** (PDF<sup>15</sup> 185kb, 17pp)

14. [http://www.openehr.org/publications/archetypes/templates\\_and\\_archetypes\\_heard\\_et\\_al.pdf](http://www.openehr.org/publications/archetypes/templates_and_archetypes_heard_et_al.pdf)

15. [http://www.openehr.org/publications/archetypes/archetypes\\_beale\\_oopsla\\_2002.pdf](http://www.openehr.org/publications/archetypes/archetypes_beale_oopsla_2002.pdf)

- In: Eleventh OOPSLA Workshop on Behavioral Semantics: Serving the Customer (Seattle, Washington, USA, November 4, 2002). Edited by Kenneth Baclawski and Haim Kilov. Northeastern University, Boston, 2002, pp. 16-32.
- *Archetypes - An Interoperable Knowledge Methodology for Future-proof Information Systems.* ([PDF](#)<sup>16</sup> 700 kb)
  - Beale T.
  - Published on the internet in 2000.

## Papers about Related Subjects

### Frame Logic (F-logic)

- *Logical Foundations of Object-Oriented and FrameBased Languages.* (See [here](#)<sup>17</sup> for link to [PDF](#)<sup>18</sup>).
- Kifer M, Lausen G, Wu J.
- JACM May 1995.
- The Archetype cADL syntax and semantics are formally speaking a synthesis of F-logic queries with terminology (the node encoding).

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16. [http://www.openehr.org/publications/archetypes/archetypes\\_beale\\_web\\_2000.pdf](http://www.openehr.org/publications/archetypes/archetypes_beale_web_2000.pdf)

17. <http://www.cs.sunysb.edu/%7Ekifer/dood/papers.html>

18. <ftp://ftp.cs.sunysb.edu/pub/TechReports/kifer/flogic.pdf>