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TOWARDS A META-METHODOLOGY FOR COLLABORATIVE NETWORKED ORGANISATIONS

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Collaborative Networked Organisations (CNOs) are conceptually well understood, and their potential benefits are commonly accepted. However, there is still a critical need for methodologies and reference models to assist and guide the organizational design of CNOs. The efforts to provide a specific CNO implementation and operation methodology can be greatly assisted by defining a meta-methodology - a method on how to produce methods - for various CNOs or CNO types. This paper describes the concepts, design and possible implementations of such a meta-methodology for the creation and operation of CNOs. Potential and actual applications of the meta-methodology are also briefly presented, followed by conclusions on the feasibility of the concept and design effort and by an outline of suggested further work.

1 INTRODUCTION

The progress of Information and Communication Technology (ICT) and the Internet has provided the technological infrastructure for worldwide cooperation. Thus, organisations can now come together for the purpose of tendering and executing one-of-a-kind (OKP) or repetitive projects, irrespective of their physical location and appear as one indivisible entity to the outside environment (client, suppliers, etc). Collaborative Networked Organisations (CNO) and their forms of manifestations (such as Virtual Organisations (VO) created out of Virtual Breeding Environments (VBE)) bring about commonly accepted benefits (such as capitalising on knowledge and market power existent in the partners) which give them the edge in a competitive situation. However, while conceptual models of CNOs are available in various levels of detail, there is still a multitude of issues to be resolved every time a form of CNO is planned, set up and operated[1]. Examples: establishing trust

[1] while an organization's agility may contribute toward its prompt response to environmental changes or opportunities, some (human) processes (e.g. trust building, sense of belonging to a community) *cannot* be rushed and thus they need to be accomplished in advance in a 'breeding environment' which will help establish *preparedness* of the partners for the quick establishment of a VE when needed.

between partners, obtaining commitment from their managements, or learning about the knowledge and culture of other potential partners. The agreement upon (and maintenance of) a stable enough common ICT infrastructure (Camarinha-Matos and Afsarmanesh, 1999) and the establishment of commonly understood reference models are crucial requirements for effective interoperability and are essential enablers of the Virtual Organisation. Commonly, a methodology has to be devised to plan and operate each collaborative network, taking into account the particular details of the future CNO and the network's purpose. Reference models may be used to facilitate the design process that results such a methodology, however they are often rather generic and thus must be first specialised for the particular purpose - which requires user familiarity with these reference models.

This paper proposes the concept of a *meta*-methodology, i.e. a method to create a suitable CNO planning and operation method, depending on the type of CNO and its envisaged purpose. The method (essentially a CNO-specific process) produced should be able to be integrated with (or exported into) project management tools and could also give advice on the aspects of the CNO that need to be modelled, as well as on the formalisms, tools, etc that can be used for such modelling.

2 META-METHODOLOGY DESIGN

2.1 Research Methods Adopted

The research question has been *whether a methodology describing how to construct a customised modelling method may be built and what other factors may (positively) influence such an endeavour.* The question is well suited for qualitative research and has provided an opportunity to employ *action research* (AR), which allows for both practical problem solving and generating and testing theory (Eden and Chisholm, 1993; McKay and Marshall, 2001).

Figure 1 shows the customized dual cycle of the action research employed, based on (McKay and Marshall, 2001) and (Checkland, 1991). The inner cycle comprises conceptual development, laboratory testing (simulation in this case) and reflection (which leads to the refinement of the method). Besides checking internal validity, this cycle aims to distil and bring the method to an acceptable level for field testing, which usually spans over long periods of time (and thus requires a suitably mature method to achieve a meaningful result). After the field test (case study), the result is to be reflected upon and triangulated[2] with the lab test result. The inner cycle may then resume until the model is ready for a second case study. Ultimately, a balance between model quality and the finite time/ resources must be struck; this determines the set of exit criteria for the method model. Results are then disseminated both towards theory (meta-methodology concept) and practice (CNO design and operation methods for particular applications). Thus, the twin purpose of action research (McKay and Marshall, 2001) is fulfilled.

The design of the research strategy employed in the meta-methodology creation (shown in Figure 1) is fully described in (Noran, 2001).

[2] triangulation is allowed on the assumption that although reality is subjectively interpreted, it is possible to build a descriptive, commonly agreed upon and understood methodology model.

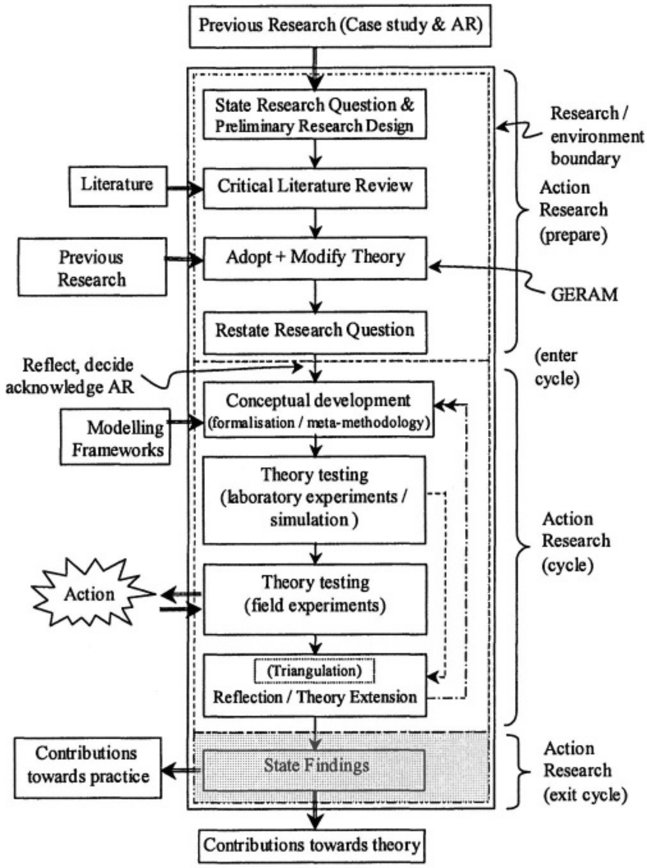

Figure 1 The research strategy (Galliers, 1992; Noran, 2001; Wood-Harper, 1985)

2.2 Critical Review: Mapping Architecture Frameworks Against a Reference

The meta-methodology aims to provide a CNO design / operation method expressed as an *activity* model (which may be extended if required into a *process* model including timing/sequence). In addition, it may provide advice as to the necessary aspects to be modelled and also propose modelling framework formalisms, languages and modelling tools. To achieve this, the meta-methodology should maintain a repository of architecture frameworks[3], out of which elements may be selected depending on the particulars of the planning and operation method being designed. In order to create such a repository, the frameworks had to be first categorized with respect to their life cycle and universe of discourse coverage in relation to the modelled artefact. This assessment had to be performed in relation to a common reference, which had to be expressive, and generic enough to accommodate the scope of all assessed frameworks. Thus, the reference chosen has

[3] used here with the meaning of *life cycle* architectures, i.e. representing all life cycle phases of the modelled artefact (ISO/TC184/SC5/WG1,2000; Noran, 2000)

been the Generalised Enterprise Reference Architecture and Methodology (or GERAM, in Annex A of (ISO/TC184/SC5/WG1,2000))[4].

The assessment of the major existing architecture frameworks has been performed in relation to the GERAM components, such as life cycle, modelled aspects, partial models, modelling methods, languages recommended, support by tools, etc. The assessment process has resulted in preliminary criteria for the selection of framework elements and modelling formalisms and tools to satisfy specific enterprise engineering requirements. The details of this assessment process are fully described in (Noran, 2003a).

2.3 Conceptual Development

The main deliverable of the application of meta-methodology is a functional model, describing step by step the method (process) to design and operate a specific CNO. This model will contain activities with associated inputs, outputs, controls, resources and possibly messages and triggers (depending on the modelling formalisms used). Some of these activities will relate to the modelling of proposed aspects (eg 'create decisional model using <formalism>').

Other models of the design/operation method may be necessary, such that together, the models express all necessary aspects for the modelling task in question. Thus, the inputs and outputs of the activities depicted in the functional model may be specified in an information model. Similarly, the activities' mechanisms (enablers) may be described in a resources model (essentially a specialised information model). In addition, a decisional model of the design / operation method may also be desirable, for which functional, or specialised decisional modelling formalisms may be used. Finally, an organizational model may also be derived by mapping the resources onto the functional model *(who does what).*

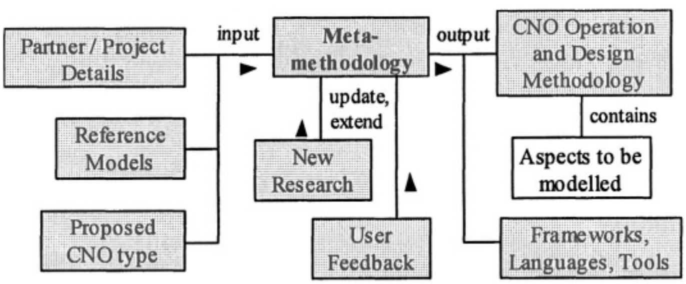

Figure 2. Simplified operational model of the meta-methodology

In Figure 2, 'partner details' refer to size, leadership, culture, type of audience, familiarity with specific modelling languages / models / tools, while 'project details' may include types of models needed and constraints. A preferred reference model and CNO type may also be fed as input to the meta-methodology.

The meta-methodology has been built using two main approaches. The first approach is a bottom-up method, whereby CNO design and operation case studies

[4] a GERAM specialisation for the Virtual Enterprise domain, namely the Virtual Enterprise Reference Architecture and Methodology (VERAM), in (Zwegers et al., 2002) and (Vesterager et al., 2001), provides modelling frameworks (Zwegers et al., 2001), (Vesterager et al., 2002)), reference models (Tølle et al., 2002) and methodologies (Tølle and Vesterager, 2002) for VEs.

published in the related literature have been researched[5] and relevant concepts have been refined and abstracted into a set of generic 'best practice' rules. The second approach of meta-methodology building enriches this set of rules with the inclusion of elements from current VE research[6], including proposed methodologies, reference models, etc concerning the functional, decisional, informational, resources and organisational aspects of the CNOs. In addition, as a result of the feedback from the experiments, new rules have been added, and the existing ones have been altered.

Current Meta-methodology Content

In the current phase, the meta-methodology resembles a set of rules, which on a 'typical' application (see Section 4.1), may accomplish all, or some of the following:

- identify the Enterprise Entities involved in the CNO and (if applicable) VBE;
- create a VBE and CNO business model able to express relations between life cycles of the identified enterprise Entities (e.g. using GERA);
- create an activity model of the CNO design and operation;
- recommend additional aspects to be modelled and formalisms / tools.

Note that the open character of the meta-methodology design allows for its refinement, extension and modification, while observing some basic constraints[7].

2.4 Theory Testing (Laboratory and Field)

The resulting set of rules had to be tested for internal and external validity; this was achieved via lab testing (by simulation) and field experimentation (via case studies), respectively. Triangulation has also been used by comparing the results from simulation with the outcomes of one case study. The results of a further case study (which is underway) will allow further triangulation and thus validation of the meta-methodology, as well as potential further refinement and extension.

3 IMPLEMENTATION

The meta-methodology is in fact a 'how-to' for the purpose of methodology building, which resembles a collection of facts applicable within certain circumstances. Thus, a straightforward way to harness it is in the shape of a knowledge base composed of a set of fixed facts and rules. This choice would facilitate the implementation of the meta-methodology as an expert system or decision support system (see Figure 3). In this case, the user would run one or more consultations (e.g. for several scenarios), the result of which will be the required methodologies. For example, the use of an open-source, web-enabled expert system shell[8] would allow focusing design efforts on the rule base, rather than on the intricacies of the expert system itself.

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[5] the initial scope of the research had to be limited to recent mainstream CNO / VO literature
[6] e.g. (Camarinha-Matos, 2002; Camarinha-Matos and Afsarmanesh, 2003; Karvoinen et al., 2002), etc
[7] e.g. adding of new rules should avoid contradicting existing rules (unless the entire knowledge base is redesigned and conflicting rules removed) and knowledge scattering
[8] such as the web-enabled Java Expert System Shell (JESS) (Friedman-Hill, 1998).

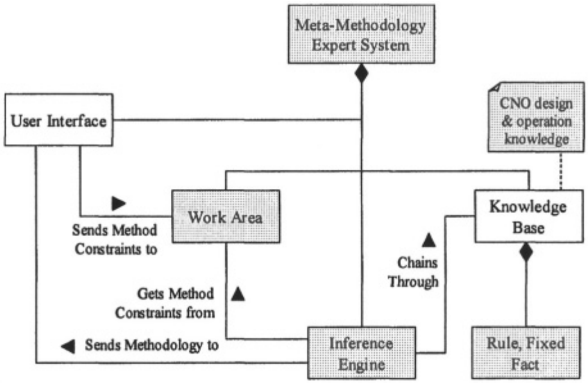

Figure 3. Possible meta-methodology implementation

4 OPERATION

The resulting methodology model will be presented in a language deemed appropriate for the target audience, and will also include activities relating to the modelling of proposed aspects (e.g. 'create CNO decisional model using <formalism>'). The user may also choose to further detail the delivered method itself by associated information, behaviour, decision, etc models as shown in section 2.3.

The meta-methodology has been tested in operation both in laboratory and field conditions. Laboratory testing has used simulation, accomplished manually using modelling tools and an expert system prototype (i.e. with a small-sized knowledge base). Thus, scenarios of various CNOs (eg VEs) have been constructed[9] and subsequently fed as input to the meta-methodology in order to produce the required deliverables. Field testing has been achieved via case studies, as described below.

4.1 Case Studies

The first case study has yielded a design (and partly operation) methodology for a Service Virtual Enterprise (SVE) (Hartel et al., 2002). The proposed CNO type has been a Virtual Breeding Environment (VBE)[10], creating SVEs as necessary. The lead partner(s)[11] wished to retain control of the requirements identification and the concept for the SVEs to be created, with the rest of the SVEs life cycle being covered by the VBE[12]. The methodology was to concentrate on the functional aspect, with information, resources and decision models to follow. The audience is partly familiar with the IDEF[13] family of languages and with the (Globemen (Global Engineering and Manufacturing in Enterprise Networks), 1999) reference model. The model's audience is made up of various levels of management and technical personnel. Finally, the modelling tool should be capable of versioning and Internet

[9] e.g. the virtual enterprise described in (Noran, 1999) and (Chalmeta, 2000)
[10] called Service Network Organisation (SNO) within the case study
[11] one or several partners that create the VBE and may influence SVEs created by the VBE.
[12] the SVE is *virtual;* thus, management roles in the SVE will be filled by the (lead) partners
[13] Integration DEFinition, a family of languages aiming to create computer-implementable modeling methods for anaylsis and design (Menzel and Mayer, 1998).

publishing (for effective maintenance).

Application of the meta-methodology (as described in Section 2.3) has resulted in a multi-level IDEF0 model of the design methodology for the VBE and for the SVEs created by it. The model was largely based on a customisation of the generic Globemen Reference Model. The tool used has been KBSI[14] AI0Win, which is web enabled and integratable with info / resources modelling (SmartER) and behaviour / simulation modelling (ProSIM) tools by the same vendors[15]. Owing to the IDEF0 language, the degree of model complexity can be adjusted according to the specific audience. The methodology has received a positive response and is in process of being further customised and implemented.

The meta-methodology has also recommended modelling of the decisional aspect of the VBE and possibly its interaction with the partners' and SVE decisional structures using GRAI-Grids (Doumeingts et al., 1998) and available reference models. This case study is described in more detail in (Bernus et al., 2002).

A second case study is in progress at the time of writing.

5 CONCLUSIONS AND FURTHER WORK

This paper has proposed the use of a meta-methodology for the creation and operation of CNOs. The work accomplished so far has demonstrated that the concept of a method to design a method for CNO design, implementation and operation is feasible and can speed up the common understanding (and thus the *preparedness*) of virtual breeding environment (and future VO) partners.

The space and scope limitations of this paper do not allow the presentation of further details of the proposed meta-methodology. However, a comprehensive description will be available in the near future in (Noran, 2004).

The meta-methodology must be subjected to further testing and refinement in order to improve the quality of its deliverables. For example, the main streams of CNO research could be reflected in linked knowledge bases, helping coordinate and focus the research efforts. The meta-methodology must also be maintained in order to reflect the evolution of CNO research as the collaborative domain matures.

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[14] Knowledge-Based Systems, Inc. www.kbsi.com

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