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D5.7.2. Tested Tool support for the NeOn Methodology for building Ontology Networks

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This deliverable presents the specific plan for the experiments to be carried out to assess the NeOn Methodology in combination with the NeOn Toolkit. Additionally, the document summarizes the preparation and executions of the experiments, and the analysis of the experiment executions.

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Change Log

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Executive Summary

This deliverable presents the concrete plan for the experiments to be carried out to assess the NeOn Methodology in combination with the NeOn Toolkit (and its plug-ins). Additionally, the document summarizes how we prepared the experiments, how such experiments were executed, and a brief analysis of the experiment executions.

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1. Introduction

One of the objectives of WP5 is to devise the NeOn Methodology for building ontology networks. This methodology comprises a range of concrete methods and methodological guidelines to support activities involved in the typical ontology lifecycle and development process. This objective had been covered by previous deliverables D5.3.1 [8], D5.3.2 [6], D5.4.1 [7] and D5.4.2 [5], and by D5.4.3 (due to M47).

In addition to such an objective, WP5 also needs to provide qualitative and (where possible) quantitative evidence that the use of the NeOn Methodology leads users to develop ontology networks faster and/or better. In other words, our aim was to assess how effective the NeOn Methodology is for the target user.

In the previous deliverables D5.6.1 [4], D5.6.2 [3], and D5.6.3 (due to M45) we analyzed a range of methods and guidelines that were at our disposal in the first three years and proposed several user studies and experiments with a subset of methods and guidelines and, in some cases, also using the NeOn Toolkit and a subset of plug-ins. In such deliverables, we reported on the execution of experiments and the results found. The methods and guidelines of the different processes and activities involved in the aforementioned experiments form part of the NeOn Methodology. It is worth mentioning that in those deliverables we focused on testing individually a limited and independent subset of methods and methodological guidelines.

However, in order to assess how effective the NeOn Methodology is for ontology developers, experiments and user studies (a) combining different methods and guidelines as part of a longer process chain (that is, as a part of a comprehensive methodology) and (b) involving support for them in the NeOn Toolkit should be carried out. For this reason, in deliverable D5.7.1 [2] we formulated our proposals for experimenting with larger chunks of the overall NeOn Methodology in combination with the NeOn Toolkit and its plug-ins.

Deliverable D5.7.1 presented a range of appropriate approaches and strategies for evaluating both the effectiveness of the methodology and the behavioural efficiency of its inclusion in the NeOn Toolkit. Additionally, the document contained a set of proposals for specific test cases, which are sequences of ontology development processes and activities that can be carried out as standalone evaluation studies or can be included as a part of larger studies. Such proposals can be summarized as follows:

- Experiments covering the process around reusing and reengineering non-ontological resources (Chapter 5 of D5.7.1).
- Experiments covering the process around reusing and reengineering ontological resources (Chapter 6 of D5.7.1).
- Experiments covering the process of reusing ontological resources but in an evolving and changing setting (Chapter 7 of D5.7.1).
- Experiments covering the creation of modules from large ontologies, module composition and integration into consistent (or paraconsistent) ontology networks (Chapter 8 of D5.7.1).
- Experiments covering some ontology contextualization activities, which include ontology mapping, alignment visualization and validation, and ontology customization (Chapter 9 of D5.7.1).

In summary, D5.7.1 presented a series of plans for the experiments to be performed at the level of NeOn Methodology as a whole, as opposed to only testing one partial method or guideline in an individual way.

Experiment plans included in D5.7.1 were presented in a 'modular' fashion rather than one, large, monolithic experiment in order to be sufficiently flexible that allows for such a dynamic 'experiment

composition' from partial sub-sets. The individual experimental strands are likely to be re-combined into coherent setups of specific experimental sessions at the time of executing a particular session. This leaves us with sufficient flexibility with respect to the various constraints that a particular user group may have.

General experiment plans described in D5.7.1 [2] should be fixed in a concrete plan, which could be executed in different settings. The concrete plan and the experiment executions are described in the current deliverable (that is, D5.7.2).

Additionally, in D5.7.1 (specifically in Chapter 4) we described a preliminary experiment carried out at the UPM that consisted in the development of an ontology network for the digital home using the NeOn Methodology. The experiment was performed in the Master's programme, within the subject "Ontologies and the Semantic Web". The emphasis in this particular preliminary study was to see the NeOn Methodology in action, without any explicit tool support or integration, as we are now proposing to test in this current deliverable (that is, D5.7.2). After performing this preliminary experiment, we drew two types of conclusions: (1) those related to the NeOn Methodology, and (2) those related to the technology used.

- With respect to the *first type of conclusions*, students commented that the NeOn Methodology was generally helpful and expressed that the NeOn methodological guidelines used during the experiment had enough detail and were well explained. Another important conclusion was that the NeOn Methodology could be used successfully with widely accepted ontology tools (such as Protégé and TopBraid Composer).
- Related to the *second type of conclusions*, when given a choice of tools, some students decided to use Protégé for developing the ontologies because they had acquired hands-on experience with this tool during the programme. Other students, however, tried to use both Protégé and NeOn Toolkit for developing the ontologies. The NeOn Toolkit at the time of the experiment was not stable yet as it lacked full support for OWL ontologies, which were available as reusable ontological resources (that is, students had interoperability problems¹ when they tried to import non-OWL DL ontologies). Hence, this is why we are now re-visiting similar experiments with a full-fledged NeOn Toolkit in a stable state. Similar rationale was observed with respect to TopBraid Composer: the main reason for using it was its quick import of the (wrong and correct) OWL ontologies and the capability to work with several ontologies at once.

It is worth mentioning that the ontologies obtained from this preliminary experiment were in general more systematic and had a higher degree of quality² than ontologies obtained in previous years (when the students did not use the NeOn Methodology).

The *concrete plan for the experiments* presented in this deliverable involved two settings involving independently Master students and PhD students who had taken the Ontology Engineering and Semantic Web subject in their programmes at the Computer Science School at, Universidad Politécnica de Madrid. Students had to execute the experiments during the period of September 2009-January 2010. In both settings students had to work in pairs and the experiments were based on a baseline for all the groups and a set of optional and additional activities different for each group.

The baseline can be summarized as follows:

- To perform the ontology requirements specification document, taking as input a brief description of a domain.

¹ It is worth mentioning that the NeOn Toolkit at that time was restricted to OWL-DL ontologies, whereas arbitrary OWL ontologies from the web tend to be OWL-Full.

² Note that the level of quality was assessed by the lecturers using their established means of assessment.

- To search possible resources (ontological and non-ontological) to be reused during the ontology development.
- To carry out the scheduling for the ontology development project.
- To develop the ontology by reusing different types of resources (ontological and non-ontological).

Additional activities were also proposed, such as to localize and evaluate the ontology, to reuse ontology design patterns, and to modularize the ontology, among others.

Deliverable D5.7.2, as was conceived, had as main objective to test the NeOn Methodology in conjunction with the NeOn Toolkit, in a series of comprehensive stories involving several ontology development processes and activities. In order to achieve such an objective, the aforementioned experiment plan had to be executed. Such an experiment plan was directly dependent on two key requirements:

- (i) *the availability of a stable version of the NeOn Toolkit and its respective plug-ins.* In addition to the NeOn Toolkit, the initial set of plug-ins needed for the experiments were the following: Watson, XD, gOntt, Labeltranslator, RaDON, and Modules; and
- (ii) *the integration of the NeOn Methodology and the NeOn Toolkit and plug-ins by means of the gOntt plug-in [6].* In this regard, there is a need to provide the gOntt plug-in with an extension point with which other plug-ins can easily 'advertise' (that is, expose) their supported activities for gOntt, which can then be automatically linked to the respective methodological 'hooks'.

We planned to perform the aforementioned concrete plan for experiments starting in September 2009 in the context of the Master and PhD programmes at the UPM.

It is worth mentioning at this point that in order to solve the restriction of the NeOn Toolkit to work only with OWL ontologies, it was decided to migrate the Toolkit to the OWL-API at the beginning of 2009. On March 13th at the TMB meeting held in Rome, the following deadlines were agreed: (1) a preview version of the code of the NeOn Toolkit integrating the OWL-API should be available to the NeOn partners by the end of April. This version had to be used for planning the required migration effort; and (2) a stable version of the NeOn Toolkit based on the OWL-API had to be released at the end of July. On May 7th, during a PMB meeting, it was agreed to postpone the deadlines and deliver the preview version in the first week of May, and the stable version, in the first week of August. It was also agreed to deliver a development guide to migrate the plug-ins to OWL-API by June 1. However, the preview version was released on the July 8th (two months later). On July 29th the NeOn Toolkit version 2.3 was released as planned, but due to some limitations new versions were released on September 16th (NeOn Toolkit for Eclipse 3.5) and October 18th (NeOn Toolkit B139).

In addition, on June 1st the development guide was not delivered. Instead, a code sprint was held in Karlsruhe in mid-August to facilitate the integration of plug-ins and the migration to the new OWL-API. After this code sprint, plug-in developers could start the migration of the plug-ins. In consequence, the first plug-ins began to be migrated in September. This implies that the first plug-ins started to be delivered at the end of September.

In order to execute the experiments that the students had to carry out later on, as it was planned, the UPM made several explicit requests to have a stable version of the NeOn Toolkit (and the necessary plug-ins) from the moment in which the decision of migrating the NeOn Toolkit was taken. The goal of these requests was to avoid failure when executing the experiments and also avoid the negative impact in the programme and in the lecturers involved (Prof. Dr. Gomez-Pérez and Dr. O. Corcho). However, this request was not satisfied. Thus, we started the Master and PhD programmes without a stable version of the OWL-API-based NeOn Toolkit.

Giving a second chance to the experiment plans, the lecturers involved in the course changed slightly the order in which the topics were to be explained with the purpose of obtaining a bit of

extra time to provide some leeway to the NeOn Toolkit developers so they could produce a stable version of the Toolkit. At the beginning of October, we had a semi-stable version of the NeOn Toolkit with a set of very recently delivered plug-ins. However, when saving ontologies that had been imported from a dereferenceable URI, a bug appeared repeatedly in that version of the NeOn Toolkit.

Due to the delays on providing a version of the NeOn Toolkit based on OWL-API (as commented before), most of the plug-in developers had not enough time to migrate their plug-ins and to have a stable version of them. For this reason and because of their preliminary state, most of the necessary plug-ins for the experiments (e.g., Modules and RaDON) did not work as expected. In addition, some plug-ins required to perform the experiments had not been delivered. Therefore, we had to delay our plans and make available the experiment definitions in both settings by mid November (on November 10 for the Master students and on November 17 for the PhD students). Also in that date, we gave the students a software package with a version of the NeOn Toolkit (NeOn Toolkit v1.3.0-B139) and some of the required plug-ins (Watson and gOntt).

However, when the students performed the different processes and activities within the experiments, they encountered different problems with the NeOn Toolkit package. These problems implied that the students could not perform successfully the experiments and that they had to carry out the hands-on without the NeOn Toolkit. Thus, we asked again for a stable version of the NeOn Toolkit and the necessary plug-ins. The stable versions of the plug-ins came at the beginning of December and the stable version of the NeOn Toolkit, on December 18th, too late for executing the experiments again.

In brief, the students could not perform the experiments because one of the two key aforementioned requirements, which is the availability of a stable version of the NeOn Toolkit, was not satisfied. This situation made that the planned experiments were unsuccessful; unfortunately, at this moment there are no student groups available with which to repeat the experiments using a new version of the NeOn Toolkit.

1.1. Main Goals and Contributions of the Deliverable

In our eagerness to test the NeOn Methodology together with the NeOn Toolkit (and its plug-ins), we present in this document the concrete plan for the experiments to be carried out for assessing the NeOn Methodology in combination with the NeOn Toolkit (and its plug-ins). Additionally, the document summarizes how we prepared the experiments, how the experiments were executed, and a brief analysis of the experiment execution is provided.

Thus, the scope of the deliverable is limited to provide

- ❑ A concrete plan for the experiments involving the NeOn Methodology and the NeOn Toolkit.
- ❑ The preparation and executions of the experiments, and an analysis of the experiment executions.

1.2. Deliverable Structure

The deliverable is structured as follows:

- ❑ Chapter 2 describes the concrete plan for the experiments involving the NeOn Methodology and the NeOn Toolkit (and its plug-ins).
- ❑ Chapter 3 explains how the concrete experiments have been prepared.

- ❑ Chapter 4 summarizes the experiment executions.
- ❑ Chapter 5 provides some analyses of the experiment executions.
- ❑ Chapter 6 presents the conclusions.

1.3. Relation with other WP5 Deliverables

The relation between this deliverable and the rest of the work done in WP5 is briefly described below:

- ❑ We planned and executed experiments for some of the processes or activities defined in the NeOn Glossary. These experiments are described in deliverables D5.6.1, D5.6.2, and D5.6.3.
- ❑ The preliminary plan for testing the NeOn Methodology as a whole, combined with the NeOn Toolkit, is included in D5.7.1.

2. Concrete Plan for the Experiments

As stated in D5.7.1 [2], the generic objective of each experiment was to provide hard evidence that participants

- a) were aware of the methodological guidance (that is, the NeOn Methodology) when using NeOn Toolkit,
- b) were able to translate a set of domain descriptive paragraphs in an ontology requirements specification document (ORSO) and to use a particular ORSO and the results of a quick search for knowledge resources in order to create an ontology project scheduling using gOntt, and
- c) used the methodological cheat sheets included in the gOntt plug-in within the NeOn Toolkit instead of consulting the facilitator or the lecturer.

As already presented in D5.3.2 [6] and in D5.7.1 [2], to embed the NeOn Methodology into the NeOn Toolkit, we proposed the scheduling tool called gOntt [6], a plug-in for the NeOn Toolkit that enables the ontology developer to draft his/her own ontology development project in terms of pathways through a sequence of processes and activities s/he identifies as relevant. Obviously, scheduling is valuable in its own right, yet the value of gOntt is actually acting as a gateway for the NeOn Methodology in the NeOn Toolkit. In addition to understanding when and where a development process or activity should be carried out, gOntt is intended to allow the ontology developer to search for methodical guidelines and also to refer to the specific guidelines and steps detailing how such a process or activity can be realized, as well as to provide direct access to the NeOn plug-in for such a process or activity.

GOntt delivers the methodological guidance to the ontology developer directly in the NeOn Toolkit. Thus, gOntt can be seen as a NeOn Toolkit meta-tool with the goal of (a) providing methodological information for each process and activity and information on the existing NeOn plug-ins for each process and activity, and (b) triggering/launching the NeOn plug-in that corresponds to a particular process or activity.

GOntt provides all the (methodological) information required to perform the different processes and activities involved in an ontology development project. That is, gOntt includes filling cards, workflows, and methodological guidelines in a way that is clear, easy and accessible for the ontology developer. GOntt also provides initial help for other plug-ins when gOntt trigger those using Eclipse Cheat Sheets.

Thus, the main goal of the experiments presented in this deliverable was to test that the participants of the experiment scheduled the ontology development with gOntt plug-in and that they (1) followed such a plan with the methodological guidelines provided by gOntt and (2) used the necessary NeOn Toolkit plug-ins for every process and activity included in the plan. The plug-ins could be triggered by gOntt in the appropriate moment of the plan.

The **concrete plan for the experiments** to test the NeOn Methodology and the NeOn Toolkit (and its plug-ins) is grounded on the following general baseline:

- To perform the ontology requirements specification document, taking as input a brief description of a domain.
- To search possible resources (ontological and non-ontological ones) to be reused during the ontology development.
- To carry out the scheduling for the ontology development project.

- To develop the ontology reusing different types of resources (ontological and non-ontological ones), using gOntt plug-in both as a scheduling tool and as a NeOn Toolkit meta-tool acting as a gateway to the NeOn Methodology in the NeOn Toolkit.

The following activities can be optionally added to the baseline:

- Localizing the ontology.
- Evaluating the ontology.
- Reusing the ontology design patterns.
- Modularizing the ontology.

This plan was mainly based on two independent settings involving (1) Master students and (2) PhD students. Both groups had to execute the experiments during the period of September 2009-February 2010 at Facultad de Informática, Universidad Politécnica de Madrid (UPM). In both settings students had to work in pairs performing the experiment baseline; different optional activities could be included in the experiments.

In this chapter we present the general experiment requirements we established in D5.7.1 and the two independent settings in which the aforementioned plan had to be applied: (1) Setting 1, which involved part-time students following a Master programme at the UPM, and (2) Setting 2, which involved PhD students also at the UPM.

2.1. Experiments Requirements

In terms of tool support, the experiments relied on an extended or packaged version of NeOn Toolkit (NeOn Toolkit plus relevant plug-ins). As stated in D5.7.1 [2], all participants were expected to use NeOn Toolkit to implement their ontologies. In order to ensure the validity of the experiments as stated in D5.7.1 [2], we needed to constrain the experiments to the use of NeOn Toolkit v1.2.x (based on KAON2) branch with the corresponding and necessary plug-ins available for this version.

Additionally, gOntt had to provide different aspects of the NeOn Methodology in the form of cheat sheets, which can be considered as an ontology developer reference guide. GOntt had also to trigger automatically NeOn plug-ins.

2.2. Experiment Setting 1

This Setting 1 involved **part-time students at Master level** that had to execute the experiments during the period of September 2009-February 2010. The Master is called “*Technologías de la Información*” (Information Technologies). The students attending this master are mostly professionals seeking to increase their qualifications rather than researchers or academics. One of the subjects of the programme is Ontologies and Semantic Web, which is delivered from October 2009 to January 2010. Students have to attend lectures (8 hours) that are accompanied by 32 hours of hands-on practice plus 2 additional hours for presenting the results of their mini-project.

During the lectures, students were instructed in the scenarios for building ontologies, identified in the NeOn Methodology. Additionally, they were provided with a detailed explanation of the methods and tools to 1) create the ontology requirements specification document (ORSD), 2) search for potential resources to be reused, 3) plan the ontology development, 4) reuse ontological and non-ontological resources, and 5) build the conceptual model. Finally, students had the opportunity and were encouraged to ask questions during the lectures or afterwards via e-mail.

The hands-on practice was to be performed off-line as homework assignments. Students had to submit each assignment result one week after the assignment description was published in the subject wiki³. For a subset of assignments, students had also to fill and submit a questionnaire.

At the end of the term, students were asked to present their mini-project, which should contain all the assignments performed during the term. The main objective of the mini-project was to improve the individual assignments. The mini-project should present the process followed to build the ontology, explaining methodological aspects and justifying decisions taken in the processes and activities performed during the ontology development. Additionally, the mini-project should include the implementation of the ontology in OWL.

The NeOn Toolkit version and the necessary plug-in versions that were to be used in this setting are described in Chapter 3.

Experiment Definition

We provided students with the following assignments to be carried out within the experiment:

- ❑ To perform the ontology requirements specification activity, taking as input a brief description of a domain selected by students. Students had to follow the **methodological guidelines for the ontology requirements specification activity provided** and had to elaborate the ontology requirements specification document (ORSD). They were asked to use the “FreeMind Software” to write the competency questions.
- ❑ To search for possible knowledge resources (ontological and non-ontological) to be reused during the ontology development. Students had to carry out a quick search for useful knowledge resources in the chosen domain using **Watson** as search engine or as plug-in. Knowledge resources can be documents (in paper or electronic), web sites, public data bases, thesauri, controlled vocabularies, ontologies, and so on. Students then were asked to briefly describe each resource, and analyze its importance in the context of the domain selected.
- ❑ To carry out the scheduling for the ontology development project. Students had to follow the **methodological guidelines for the scheduling activity** provided and had to create the schedule for the ontology project in two different ways:
 - without the *gOntt plug-in* (using, for example, Excel), and
 - with the **gOntt plug-in** in the guided fashion, completing the initial plan with the missing and necessary processes and activities for the project.
- ❑ To develop the ontology by reusing different types of knowledge resources. Students had to perform the ontology conceptualization before going into the implementation activity. In this part of the experiment students were told to
 - Analyze the need of reusing and re-engineering knowledge resources and justify the criteria used to select them among a set of knowledge resources. Students had to follow the **methodological guidelines for reusing and re-engineering knowledge resources** provided.
 - Elaborate the upper-level conceptual model, indicating the reuse of knowledge resources.
 - Elaborate the detailed conceptual model, identifying the main concepts and relations.
 - Implement a part of the ontology in the **NeOn Toolkit**, using the *gOntt plug-in* as a NeOn Toolkit meta-tool acting as a gateway for the NeOn Methodology in the NeOn Toolkit.

³ <http://delicias.dia.fi.upm.es/wiki/index.php/Master09-10>

- Optionally, evaluate the ontology using the **RaDON plug-in**.

Students were free to select any domain to carry out the experiment. They were allowed to work in pairs and were asked to describe in detail how they had performed each aforementioned assignment.

2.3. Experiment Setting 2

This Setting 2 involved **students at PhD level** that had to execute the experiments during the period of September 2009-February 2010. These students attended the master “*Máster de Investigación*” (Research Master) seeking to increase their competences in research issues. One of the subjects of the programme is Ontologies and Semantic Web, which is delivered from October 2009 to January 2010. Students have to attend lectures (8 hours) that are accompanied by 32 hours of hands-on practice plus 2 additional hours for presenting the results of their mini-project.

During the lectures, students were instructed in the scenarios for building ontologies, identified in the NeOn Methodology. Additionally, they were provided with detailed explanation of the methods and tools to create the ontology requirements specification document (ORSD), to search for potential resources to be reused, to plan the ontology development, to reuse ontological resources, non-ontological resources, and ontology design patterns (ODPs), and to build the conceptual model. Finally, students had the opportunity and were encouraged to ask questions during the lectures or afterwards via e-mail.

The hands-on practice had to be performed off-line as homework assignments. Students had to submit each assignment result one week after the assignment description was published in the subject wiki⁴, unless other timing was established for the assignment. For a subset of assignments, students were requested to fill and submit a questionnaire.

At the end of the term, students had to present their mini-project, which should contain all the assignments performed during the term. The main objective of the mini-project was to improve the individual assignments. The mini-project had to present how the NeOn Methodology had been applied to build the ontology, justifying adequately aspects like scheduling, requirement specification, knowledge resources reused, conceptualization and evaluation. Additionally, the mini-project had to include the implementation of the ontology in OWL. The NeOn Toolkit version and the necessary plug-ins versions used in this setting are described in Chapter 3.

In this section, first we present a general view of the experiment definition involving the different processes and activities needed for the ontology development in this setting, and second, a specific experiment definition for the reuse of ontology design patterns (ODPs).

2.3.1. A general view of the experiment definition

Students were provided with the following paragraph about the concrete domain to be modelled in the ontology”

“The International Olympic Committee decides to rely on semantic technologies to manage information related to the Olympic Games. For this purpose, such a committee needs an ontology network able to model information about the sports (summer and winter), about countries and teams involved, about venues and dates, and about medals and winners.”

Students were told to work in pairs; and each group had to focus on winter or summer sports then, they were asked to select one particular sport and define it in detail.

⁴ <http://delicias.dia.fi.upm.es/wiki/index.php/MasterRD09-10>

Students were also provided with a list of assignments that were to be performed within the experiment; the list included the following:

- ❑ To perform the ontology requirements specification activity, taking as input the paragraph provided about the domain to be modelled. Students had to follow the **methodological guidelines for the ontology requirements specification activity** provided and elaborate the ontology requirements specification document (ORSD). Students should use the “FreeMind Software” to write the competency questions.
- ❑ To search for ontological and non-ontological resources that could be reused during the ontology development. Students were to search non-ontological resources in Internet and ontological resources using **Watson**.
- ❑ To carry out the scheduling for the ontology development project. Students were told to follow the **methodological guidelines for the scheduling activity** provided and create the schedule for the ontology project using the **gOntt plug-in**.
- ❑ To reuse ontology design patterns (ODPs). Students had to follow the **methodological guidelines for reusing ODPs** provided and use the **XD plug-in**. This assignment is explained in detail in subsection 2.3.2.
- ❑ To develop the ontology reusing different types of resources (ontological resources, non-ontological resource, and ODPs). Students had to perform the ontology conceptualization before going into the implementation activity. In this part of the experiment students were asked to
 - Analyze the need of reusing and re-engineering knowledge resources and justify the criteria used to select them among a set of knowledge resources. Students had to follow the **methodological guidelines for reusing and re-engineering knowledge resources** provided
 - Elaborate the upper-level conceptual model, indicating the reuse of knowledge resources.
 - Elaborate the detailed conceptual model, identifying the main concepts and relations.
 - Implement a part of the ontology in the **NeOn Toolkit**, using the gOntt plug-in as a NeOn Toolkit meta-tool that acts as a gateway for the NeOn Methodology in the NeOn Toolkit.
 - Optionally, evaluate the ontology using the **RaDON plug-in**.

Students were asked to describe in detail how they had performed each of aforementioned assignments.

2.3.2. Assignment on methodology and tool support for reusing Content ODP

The goal of this part of experiment setting 2 was to perform an initial evaluation of the XD methodology (as presented in D5.4.2 [5] and more recently in D2.5.2 [1]) together with the tool support for this methodology, the XD Tools NeOn Toolkit plug-in (as described in D2.5.2 [1]). Unfortunately, the timing of the delivery of the tool support for XD and the experiment reported here made it impossible to conduct a larger study within the runtime of the NeOn project. Instead, we decided to perform a smaller study, using only one group of participants and one experiment session. This excluded the possibility of making a comparative study, i.e., comparing the results and experiences of ontology designers without methodology and tool support with the results and experiences of those being exposed to both methodology and the XD Tools. Therefore, we decided to focus on the user experience, for example, by recording the perceived usefulness of the methodology and tool, and collecting feedback for both. The resulting ontologies were intended to

be used to confirm any perceived ease of use. To do this, we studied common mistakes and different ontology quality attributes.

As already mentioned, the assignment involving XD was part of a larger experiment concerning the complete NeOn Methodology and the NeOn Toolkit. Due to this fact, the students already had experience in basic ontology design using the NeOn Toolkit and in the reuse of online ontologies. However, the participants should still be classified as novice ontology engineers, since this course was for many of them their first contact with ontologies.

The session on XD and XD Tools consisted of two parts: a two-hour tutorial and a three-hour hands-on exercise performed by the students (working in pairs). During the tutorial part, ODPs were introduced on a theoretical level, together with some modelling examples, and the XD methodology was described in detail, i.e. each step was explained through detailed guidelines. The participants also had the opportunity to ask questions during the tutorial or afterwards via e-mail. Questions related to the actual solution of the modelling exercise were not to be answered, but general or technical questions were allowed.

The second part, i.e., the hands-on session, was to be performed off-line, that is, the students would get a mandatory homework task to be performed in pairs during a 3 hours time slot at a time and place of their choice (within one week of the tutorial). The participants were instructed to submit their results after 3 hours, whatever the state of the ontology at that time, in order to normalize the setting with respect to the time spent on the modelling. When the participants submitted their results, they were to receive a questionnaire containing questions⁵ about their experience and their perception of the methodology and the tool. The questionnaires were to be filled out individually, and returned within one week.

The detailed assignment description was posted in the training area of the ODP portal⁶. In summary, the participants got a set of requirements, i.e., Competency Questions (CQs), together with an example scenario describing typical knowledge that the ontology should be able to provide (in this case, knowledge about “theatre productions”). They were also instructed to utilize the Content ODP repository in the ODP portal⁷, where at that time 55 Content ODPs for various domains were available. Instructions included the use of the NeOn Toolkit and optionally (in case they found it useful) the XD Tools plug-in supporting parts of the XD methodology. Alternatively, the patterns could be accessed directly through the ODP portal, downloading the OWL building blocks of the desired patterns and importing them into the ontology using the NeOn Toolkit import functionality.

⁵ The questions consisted of 20 sentences that the participants had to rate on a 5-point Likert scale, one multiple choice question asking how the participants used the patterns, one question asking about the number of patterns they used, and two open questions; one asking about any specific problem they had experienced, and the other asking the participants why they found the patterns useful (if so).

⁶ http://ontologydesignpatterns.org/wiki/Training:Autumn_2009_-_ODPs%40UPM

⁷ <http://ontologydesignpatterns.org/wiki/Submissions:ContentOPs>

3. Experiments Preparation and Selection of the NeOn Toolkit Package

In terms of tool support, as already mentioned in Chapter 2, experiments relied on a packaged version of NeOn Toolkit (NeOn Toolkit plus relevant plug-ins). The relevant plug-ins needed to perform the experiments were, as stated in Chapter 2, the following: Watson, gOntt, RaDON, and XD.

With respect to the NeOn Toolkit version, in **D5.7.1 [2] (February 2009)** it was stated the **necessity for constraining the experiments to the use of the NeOn Toolkit v1.2.x (based on KAON2) branch** with the corresponding and required plug-ins available for this version. Thus, in September 2009, we tested the last available version of the NeOn Toolkit based on KAON2, that is, version 1.2.3.

During the testing of such a version, the following problems arose:

- The XD plug-in was not available for NeOn Toolkit v1.2.3, because this is a new plug-in for the NeOn Toolkit based on OWL-API.
- The NeOn Toolkit v1.2.3 failed when importing OWL ontologies, which were not OWL-DL.

Because of these problems and the fact that the NeOn Toolkit developer team were mostly focussed on the NeOn Toolkit based on OWL-API, **the best way of executing the planned experiments was through the use of the new version of the NeOn Toolkit based on the OWL-API.**

Then, we analyzed the evolution of the OWL-API-based NeOn Toolkit in order to decide which version to use in the experiments.

Based on the initial plan of delivering a preview version of the OWL-API-based NeOn Toolkit in the first week of May (as stated in Chapter 1), we expected to have the chance of evaluating internally the new OWL-API-based NeOn Toolkit in September, and the plug-ins before giving the package to the students. However, as explained in Chapter 1, such an initial plan for the NeOn Toolkit was dismissed. Therefore, when in September 2009 we analysed the version of the Toolkit to be used in the Master and PhD programme, we found out that the NeOn Toolkit based on OWL-API was not stable and that the plug-ins developers had just started to migrate their plug-ins.

At the beginning of October, we had a semi-stable version of the NeOn Toolkit and a set of recently delivered plug-ins. Most of the plug-ins did not work as expected because they were in a preliminary state. In addition, some plug-ins required to perform the experiments had not been delivered

Because of the aforementioned situations, **we delayed the experiments with the students until mid November.** At that date, we selected the last version of the OWL-API-based NeOn Toolkit available on November 6th, that is, NeOn Toolkit v1.3.0-B139. We also tested this version, which seemed to allow a more stable behaviour when developing OWL ontologies importing other OWL ontologies. The only case in which such a version also failed was due to an error⁸ occurred when the user wanted to save an ontology project that includes ontologies imported from Internet (that is, remote ontologies).

In spite of this error, finally, **we decided to modify the execution of the experiments that the students had to conduct and we moved to the NeOn Toolkit v1.3.0-B139 in order to carry out the planned experiments.** Thus, we created the experiment package with a version of the NeOn Toolkit and the required plug-ins. In fact, we created three different packages, as presented in Table 1, which were delivered to the students.

⁸ This error could avoid warning students about it and advising them to first save locally the remote ontology and then to import it to the NeOn Toolkit.

Package 1 (At the beginning of November)	Package 2 (Mid of November)	Package 3 (At the beginning of December)
NeOn Toolkit 1.3.0-B139	NeOn Toolkit 1.3.0-B139	NeOn Toolkit 2.3.0-B177
gOntt 1.3.4	gOntt 1.3.4	gOntt 1.3.4
Watson 1.1.0	Watson 1.1.1	Watson 1.1.2
		XD 0.0.8

Table 1. Software packages of the experiment

The packages presented in Table 1 contain the following information about the different aspects that gOntt should provide, namely, (a) methodological guidelines in the form of cheat sheets, (b) the possibility of triggering NeOn plug-ins, and (c) user help on how to start a particular triggered plug-in.

- *Package 1* to be used in Settings 1 and 2:
 - gOntt 1.3.4 provides methodological guidelines for the processes and activities described in WP5 deliverables [7, 6, 5].
 - Watson 1.1.0 implements gOntt extension point to allow its launch directly from gOntt.
 - Watson 1.1.0 does not include the initial user help.
- *Package 2* to be used in Settings 1 and 2:
 - gOntt 1.3.4 provides methodological guidelines for the processes and activities described in WP5 deliverables [7, 6, 5].
 - Watson 1.1.1 implements gOntt extension point to allow its launch directly from gOntt.
 - Watson 1.1.1 includes the initial user help.
- *Package 3* to be used in Setting 2 in the ODPs assignment:
 - gOntt 1.3.4 provides methodological guidelines for the processes and activities described in WP5 deliverables [7, 6, 5].
 - Watson 1.1.2 implements gOntt extension point to allow its launch directly from gOntt.
 - Watson 1.1.2 includes the initial user help.
 - XD 0.0.8 implements gOntt extension point to allow its launch directly from gOntt.
 - XD 0.0.8 includes the initial user help.

4. Experiments Executions

In this chapter, we describe how experiments have been executed both in Setting 1 (Section 4.1) and in Setting 2 (Section 4.2).

4.1. Experiment Execution: Setting 1

The lectures related to the NeOn Methodology were held in November-December 2009. The sessions involved 14 students. The lectures contained introductory material on the existing methodologies for building ontologies; then a detailed explanation of the NeOn Methodology was given. Such an explanation included the set of scenarios for building ontology networks, the requirements specification activity, the establishment of the ontology life cycle and the scheduling for the whole development project, and the reuse and reengineering of different types of knowledge resources for building the ontology. Additionally, an example on how to develop an ontology network in the SEEMP European project was also presented and explained.

After the lectures, students were asked to carry out the hands-on practice off-line as homework assignments. Students had to submit each assignment result one week after the assignment description was published in the subject wiki, unless other timing were established for the assignment. For a subset of assignments, students were also asked to submit a questionnaire, which had to be filled out individually.

The *first, second, and third assignments* involved respectively (a) the ontology requirements specification activity, (b) the search of knowledge resources to be reused during the ontology development (using Watson as a search engine or as a NeOn Toolkit plug-in), and (c) the scheduling of the ontology development project (first without using gOntt plug-in and second using gOntt plug-in). Students had to submit these assignments by November 25; besides, they had to send a questionnaire about the methodological guidelines for the ontology requirements specification activity and a questionnaire⁹ about gOntt plug-in.

The students working in pairs submitted the three assignments and the requested questionnaires on time.

The *fourth assignment* involved the development of the ontology by reusing different types of knowledge resources. This assignment, as explained in Section 2.2, implied (a) implementing part of the ontology in the NeOn Toolkit, using the gOntt plug-in as a NeOn Toolkit meta-tool (acting as a gateway to the NeOn Methodology in the NeOn Toolkit) and, (b) optionally, evaluating the ontology using RaDON plug-in. The students had to submit this assignment by the end of December.

During the execution of this last assignment, some groups reported problems with the NeOn Toolkit. The main problems experienced were errors when saving the ontology and when adding additional information about classes. Because of these problems, we had to postpone the submission of this fourth assignment until the end of January.

⁹ The questionnaire is divided in two main parts: (1) one related to background knowledge with 4 questions with fixed answers; and (2) the other related to the experiences had when using the gOntt plug-in. The second part includes 10 questions with fixed answers and an open question in which they were asked to express other comments or suggestions about the gOntt plug-in.

4.2. Experiment Execution Setting 2

The lectures related to the NeOn Methodology were held in the period between November 2009 and January 2010. The sessions involved 18 students. The lectures contained a brief introduction to the existing methodologies for building ontologies. Then, a detailed explanation of the NeOn Methodology was given. Such an explanation included the set of scenarios for developing ontology networks, the requirements specification activity, the establishment of the ontology life cycle and the scheduling for the whole development project, the reuse and reengineering of different types of knowledge resources (non-ontological resources, domain ontologies and general ontologies) for building the ontology, and the reuse of ontology design patterns (ODPs) during the ontology building.

After the lectures, students had to perform the hands-on practice off-line as homework assignments. Students had to submit each assignment result one week after the assignment description was published in the course wiki, unless other timing was established for the assignment. For a subset of assignments, students were asked to fill and submit a questionnaire.

The *first, second, and third assignments* involved respectively (a) the ontology requirements specification activity, (b) the search of knowledge resources to be reused during the ontology development (using Watson), and (c) the scheduling of the ontology development project (using gOntt plug-in). The students had to submit these assignments by December 1; besides, the students were asked to send a questionnaire about the methodological guidelines for the ontology requirements specification activity and a questionnaire¹⁰ about gOntt plug-in.

The students working in pairs submitted the three assignments and the requested questionnaires on time.

The *fourth assignment* involved the reuse of ODPs within the development of the ontology. The execution of this assignment is described in Section 4.2.1.

The *fifth assignment* involved the development of the ontology by reusing different types of knowledge resources. This assignment, as explained in Section 2.3.1, implied (a) implementing part of the ontology in the NeOn Toolkit, using the gOntt plug-in as a NeOn Toolkit meta-tool (acting as a gateway to the NeOn Methodology in the NeOn Toolkit), and, (b) optionally, evaluating the ontology using RaDON plug-in. The students had to submit this assignment by February 11th.

4.2.1. Execution of the assignment on methodology and tool support for reusing Content ODP

The tutorial session was held in December 2009. The session had a total of 15 participants. The two-hour tutorial dealt with patterns in general and Logical and Content ODPs in particular and included a lecture on the XD methodology and examples of Content ODP reuse. The tool was not introduced specifically, since the students had already worked with the NeOn toolkit previously, and it was not mandatory for the homework exercise to use the XD Tools plug-in. A constrain of the tool was that the NeOn Toolkit currently did not support the SPARQL query language; hence the unit testing part of the XD methodology (see D2.5.2 [1]) was impossible to perform in practice. A short instruction on how to operate the XD Tools plug-in was provided on the exercise page of the ODP portal. The exercise was introduced at the end of the lecture, and finally there was some time for questions, though no questions were asked.

During the following week the students had to spend 3 hours per group (pair groups) on trying to solve the modelling problem given in the homework exercise, and then submit their solution.

¹⁰ The questionnaire is divided in two main parts: (1) one related to background knowledge with 4 questions with fixed answers; and (2) the other related to the experiences had when using the gOntt plug-in. The second part includes 10 questions with fixed answers and an open question in which they were asked to express other comments or suggestions about the gOntt plug-in.

During the first few days no solutions were submitted, but then some groups sent e-mails reporting problems with the tool. The main problems experienced were errors when saving the ontology, errors when adding additional information about classes, and the reasoner not working properly (e.g. giving no results at all). The problems were investigated by both the core NeOn Toolkit developers and developers of the XD Tools, but they turned out to be impossible to solve during the student assignment's week. Based on this fact, the students were told to use only the core NeOn Toolkit, not the XD Tools, and import the patterns from the ODP portal directly. Even with this configuration, the students reported so many problems that in the end they were advised to use whatever tool they liked to complete the task. However, after spending the available three hours, most student groups were not able to produce any reasonable ontology.

They were all given the final questionnaire, which was then returned within one week (only 6 out of 15 participants returned the questionnaire). However, the results of the questionnaires cannot be used as a basis for a proper analysis about the user experience with the XD methodology nor with the XD Tools, since most students were not able to use the XD Tools and used only parts of the methodology. Even those groups that did manage to produce a reasonable result might have been too influenced by the problems of the tool support to be able to provide unbiased feedback on the methodology.

5. Analysis of the Execution of the Experiments

The main conclusion we can draw from the *general experiments performed in both settings* (1 and 2) is that it is not possible to draw any reliable conclusions on the assessment of the NeOn Methodology and the NeOn Toolkit (and its plug-ins) because

- First, experiments should have relied on a packaged version of NeOn Toolkit (NeOn Toolkit plus relevant plug-ins). As stated in D5.7.1 [2], we needed to constrain the experiments to the use of NeOn Toolkit v1.2.x (based on KAON2) branch with the corresponding necessary plug-ins available for this version. However, this was not possible because the last available version of the NeOn Toolkit based on KAON2, that is, the version 1.2.3, had the following problems:
 - The XD plug-in was not available for the NeOn Toolkit v1.2.3.
 - The NeOn Toolkit v1.2.3 failed when importing non-OWL DL ontologies¹¹.
- Second, due to the aforementioned inconveniences, we decided to base the experiments on a version of the OWL-API-based NeOn Toolkit, concretely, on the NeOn Toolkit v1.3.0-B139 (as explained in Chapter 3). However, during the execution of the assignments, some participant groups from both settings reported problems with this version of the NeOn Toolkit. The main problems experienced were errors when saving the ontology and when adding additional information on classes.

Because of these problems, the only thing we could do was to analyze how students perceived the gOntt plug-in as a NeOn Toolkit meta-tool.

As already mentioned in Chapter 2, gOntt delivers the methodological guidance to the ontology developer directly in the NeOn Toolkit. That is, one of the main goals of gOntt is to provide methodological information for each process and activity, and information about the existing NeOn Toolkit plug-ins for each process and activity. Additionally, gOntt is able to launch the NeOn plug-in that corresponds to a particular process or activity.

In order to analyze the students' perception of gOntt, we selected two questions about gOntt plug-in from the questionnaire that students (in pairs) filled and delivered together with the corresponding assignments. The answers to these questions from students in Setting 1 are presented in Table 2, and from students in Setting 2, in Table 3.

Question	Distribution of answers			
	A good and useful idea?	Just a nice functionality?	A useless idea?	I don't know
Do you think the idea of including methodological guidelines in the gOntt plug-in is:	5	2	0	0
Do you think the idea of including the possibility of triggering gOntt plug-ins from NeOn Toolkit plug-ins from the gOntt plug-in is:	2	2	0	3

Table 2. Answers to the questions selected from the gOntt questionnaire (Setting 1)

¹¹ NeOn Toolkit v1.2.3 is restricted to OWL-DL ontologies.

Question	Distribution of answers			
	A good and useful idea?	Just a nice functionality?	A useless idea?	I don't know
Do you think the idea of including methodological guidelines in the gOntt plug-in is:	5	4	0	0
Do you think the idea of including the possibility of triggering gOntt plug-ins from NeOn Toolkit plug-ins from the gOntt plug-in is:	4	2	0	3

Table 3. Answers to the questions selected from the gOntt questionnaire (Setting 2)

Taking into account the answers presented in both Table 2 and Table 3, we can say that the students in general perceive as a positive and useful issue the fact that gOntt provides them with methodological guidelines for each process and activity involved in the ontology development. With respect to the functionality of triggering NeOn plug-ins, the opinion here is divided, and it must be added that some students could have not exploited that functionality due to the aforementioned problems with the NeOn Toolkit package.

Additionally, students have provided us with general comments in the open question included in the questionnaire. Such comments can be summarized as follows:

- gOntt is considered as a good help, specially for beginners.
- gOntt is seen as a centralised environment that allows the user to obtain methodological information without having to search in external files (the methodology taught included the reference to the respective deliverables).
- gOntt is considered a useful and didactic plug-in.
- gOntt provides of the means for both structuring and centralizing the management of the ontology development.

Finally, we also include here the particular analysis and conclusions drawn from the **assignment on methodology and tool support for reusing Content ODP, performed in Setting 2**. The main conclusion we can draw from this assignment is that it is not possible to reach any reliable conclusions about the use of the XD methodology because:

1. The tools did not properly support the methodology to start with, i.e., the core NeOn Toolkit lacked support for unit testing (i.e. SPARQL queries), and XD is a test-driven methodology that heavily relies on such support.
2. The tool support that did exist was not properly integrated and tested, i.e., the XD Tools plug-in assumed some functionality of the core NeOn Toolkit that was in fact not supported in the way expected, and the tools still had some “bugs” that made them behave in unexpected ways in certain situations.
3. The training given turned out to be too theoretical, and hence not enough to permit the students to work out all the above mentioned tool-related issues. For example, if the students would have had an additional practical training session on the use of ODPs with the tools, they might have been able to use the tools for the exercise despite the above mentioned shortcomings, but with a non-tool based tutorial, the assignment was a failure.

Despite these obvious deficiencies, some of the questionnaire answers, in which the participants were most in agreement, could still be useful as an indication of their overall impression. Table 4 summarizes some of their answers (the numbers represent the absolute number of answers). The

answers were selected from a Likert scale ranging from “Strongly disagree” (SD) to “Disagree to some extent” (D) to “Neither agree nor disagree” (N) to “Agree to some extent” (A) and to “Strongly agree” (SA). In total 6 out of the 15 students submitted the questionnaire. The reason for the low response rate is that it was made optional when we realised the severe problems they were experiencing with the tools.

Question	Distribution of answers				
	SD	D	N	A	SA
I found the tool used for the experiment easy to use.	0	3	2	1	0
The patterns were clear and easy to understand.	0	0	1	5	0
It was easy to find the right pattern for solving a specific modelling issue.	0	4	1	1	0
The patterns were easy to use.	0	1	3	2	0
The XD methodology helped me to organize my work while modelling.	0	0	2	4	0
In general, I found the patterns useful.	0	0	1	4	1

Table 4. Answers to the questions selected from the ODP questionnaire (Setting 2)

The problems that the participants experienced, and listed in the answers to the open questions, were all related to the tool. One of the open questions additionally asked the respondents to express their opinion in case they found the patterns useful, and had stated so in a previous question. The reasons mentioned included that (1) with the patterns you are able to get a first solution built very quickly and (2) patterns inspire solutions and help understand the modelling problem. Additionally, one participant pointed out that he found useful even very general patterns.

In summary, the results of this experiment confirm the results of previous experiments, reported in D5.6.2 [3], regarding the usefulness of Content ODPs. Unfortunately, due to severe problems in tool integration and availability of essential functionalities (such as SPARQL support), we were not able to derive any conclusions about the efficiency and usefulness of the XD methodology, nor about the XD Tools, from this experiment. We can therefore only conclude the same as in the previous experiments: Content ODPs are useful for inexperienced ontology engineers, but tool support for pattern selection and reuse is definitely needed.

6. Conclusions

As already mentioned, deliverable D5.7.2 was conceived to test the NeOn Methodology in conjunction with the NeOn Toolkit (and its plug-ins) in a series of comprehensive stories involving several ontology development activities and processes. To perform this testing, we elaborated a specific plan for experiments involving both the NeOn Methodology and the NeOn Toolkit and its plug-ins. Such a plan was directly dependent on two key requirements:

1. the *availability of a stable packaged version of NeOn Toolkit* (NeOn Toolkit plus relevant plug-ins). As stated in D5.7.1 [2], we needed to constrain the experiments to the use of NeOn Toolkit v1.2.x (based on KAON2) branch with the corresponding necessary plug-ins available for this version. The initial set of plug-ins needed for the experiments were Watson, XD, gOntt, Labeltranslator, RaDON, and Modules.
2. the *integration of the NeOn Methodology and the NeOn Toolkit and plug-ins by means of the gOntt plug-in* [6]. gOntt should provide different aspects of the NeOn Methodology in the form of cheat sheets, which can be considered as an ontology developer reference guide. gOntt should also automatically trigger the NeOn Toolkit plug-ins.

The **first key requirement** was not satisfied, because the last available version of the NeOn Toolkit based on KAON2, that is, the version 1.2.3, had the following problems:

- the XD plug-in was not available for NeOn Toolkit v1.2.3.
- the NeOn Toolkit v1.2.3 failed when importing OWL ontologies, which were not OWL-DL.

However, we tried to satisfy in any way such a key requirement. For this reason, we tried doing the experiments using a version of the NeOn Toolkit based on OWL-API, concretely on the NeOn Toolkit v1.3.0-B139. This version was not stable enough since students reported different problems when saving the ontology and when adding complementary information about classes. Besides, such a version lacked support for unit testing (i.e. SPARQL queries), which was needed for the reusing of ODPs.

The **second requirement** was satisfied, that means that the NeOn Methodology is integrated in the NeOn Toolkit by means of the gOntt plug-in. The gOntt plug-in includes methodological guidelines for the processes and activities described in WP5 deliverables [7, 6, 5] and is a reference guide for ontology developers. Additionally, gOntt allows launching the NeOn Toolkit plug-ins needed for the experiments, as presented in Chapter 3.

Because of the failure of fulfilling the first key requirement on time¹², we were not able to perform the experiments of combining the NeOn Methodology and the NeOn Toolkit (and its plug-ins) as were conceived in D5.7.1 [2]. Thus, we can not extract any useful conclusion about the assessment of the NeOn Methodology together with the NeOn Toolkit.

The only analysis we could make was related to how students perceived the integration of the NeOn Methodology and the NeOn Toolkit and plug-ins by means of the gOntt plug-in.

In this sense, we can conclude that students were aware of methodological guidance (that is, the NeOn Methodology) when using the NeOn Toolkit, and in most cases they used the methodological cheat sheets within the NeOn Toolkit instead of consulting the lecturer.

¹² It is worth mentioning that the first requirement (the availability of a stable packaged version of the NeOn Toolkit) was achieved too late (NeOn Toolkit 2.3 was officially released on February 8, 2010). This situation implied that UPM had no leeway to replan again the experiments.

Additionally, gOntt was perceived as a good help (1) to organize ontology development projects and (2) to execute development projects, with the advantage of having centralised both the methodological guidelines needed to perform each process and activity and the information on which NeOn Toolkit plug-ins can be used for a particular process or activity, and be launched directly from gOntt.

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