Sharing by separation of concerns

Hilda Tellioglu

Institute of Design and Assessment of Technology
Vienna University of Technology, Austria
hilda.tellioglu@tuwien.ac.at

WWW home page: http://media.tuwien.ac.at/index.php?id=7

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Abstract. This paper is about studying how organisations can share data without losing control about one’s position, role, and importance in a cooperation. We introduce the framework of sharing by separation of concerns as a model. Based on an ethnographic study, we apply our framework in a real work context. We show how this framework offer an easy solution to share certain information across organisational boundaries before concluding our paper.

Keywords: Concern, knowledge sharing, separation of concerns.

1 Introduction

Exchange of knowledge by sharing artefacts and experiences is the basis to establish cooperation between enterprises. At the same time it is a delicate endeavour with several aspects. How much knowledge can be shared without losing one’s position, role, and importance in a cooperation? How much is necessary to communicate with others to get answers to one’s questions without making confidential data transparent to a partner in a competitive situation? How can the information infrastructure be designed to make all aspects of sharing automatically without creating additional effort for the domain workers?

Several studies show how difficult it is to protect boundaries and cross them if needed when it comes to cooperation between companies [4] [10]. In an earlier work, we introduced the model of multi-context systems to show conceptually and based on a spreadsheet prototype [11]. It was created after several ethnographic studies in an European research project MAPPER\(^1\). It shows how to protect the work domain of single actors cooperating, but at the same time how to provide enough openness to let others help and interact. Multi-context systems as a new framework help define, capture, and analyse the different levels

\(^1\) Model-based Adaptive Product and Process Engineering: FP6-IST-016527-MAPPER.
of data used and exchanged in a work group. This makes overcoming problems of boundary crossings between teams possible.

Another way to approach the problem of secure sharing mainly to support cooperation at work is using the well-known concept of the separation of concerns from computer science [1] [8] [3]. Through modularity of programming, encapsulation, and information hiding, a computer program can be separated into distinct features of which functionality does overlap as little as possible. As an important design principle, separation of concerns is applied in several programming languages, all using different mechanisms for implementation [9], like objects, layers, services, procedures, patterns, or aspects [12] [2] [7] [5].

In this paper we want to introduce a framework based on the notion of concern. It seems to be useful when studying cooperation between actors or organisations. After studying user behaviours, problems, solutions to problems, and the interaction between users to deal with all aspects of cooperative work, we came up with this framework to introduce a solution to knowledge management and sharing within and across organisations. This framework can also be easily implemented by using ontologies and composition rules to configure actions which are allowed or prohibited. We do not use concern as a metaphor, we use it as a framework to understand and model sharing across organisational boundaries and to implement an IT infrastructure for sharing by separation.

In the next section we will describe the concept of concern, meta-concern, and composition specification (Section 1.2). With a real field example we want to show first a setting in which secure sharing is needed but not provided (Section 3). Second, we illustrate how our framework of separation of concerns can be applied to such a cooperative work environment (Section 4). Then we conclude our paper.

2 The concept of concern

A concern is a formal and abstract construct created and maintained in an organisation. It is a container of data, data relations, composition rules, and methods including actions and operators for data access and composition. Figure 1 illustrates an exemplified model of the framework by showing relations between four concerns and methods. Boundary crossing is provided where access can take place between different concerns by means of methods related to them. A concern contains the reference to the data that is relevant and the data repository. It also relates data to each other. It has an owner who has complete access to everything in the concern. Concerns are separated by definition, and can be composed if defined so. Having a state, a concern can be protected or open for composition, it can be deprecated or relevant for current use.

Each concern is originated by single persons, work groups, or organisations. It can be of different types, project-, process-, product-, person-related, or composed. It is dynamic, customisable, self-defined, and self-configured. Different types of concern can be composed if there are rules and methods provided, es-
especially in case of interaction and exchange and to make composite behaviour possible across different concerns. The cross-cutting is provided by data logging.

A concern can be defined by the meta-concern definition language (MDL). It is a XML-based definition language with elements name, description, link to data repository, examples, relationships to other concerns, which is the base for composition specification. Meta-concerns define the relevant data for business, the entities which contain data and their relationships. The data is given as a reference to data repositories or IT infrastructures organisations have established for data management. Concerns with the composition rules define additional constraints for sharing and data access within and across organisations.

Concerns can be instantiated dynamically if there is a problem or an event triggering exchange or sharing between different persons, groups or people, or organisations. This can happen by means of access or composition of concerns, sometimes through crosscutting concerns. Composition rules embedded in a concern define and regulate relationships between concerns. A composition specification language (CSL) is used to specify the composition rules for each concern.

In the following section we want to show a real work setting in which sharing is needed but not provided.

3 Field Example: The Case

In the scope of the project MAPPER we spent several days observing ongoing work, combining video observations with field notes and open interviews. In this section we first want to show the case we were studying to highlight how knowledge and memory are constructed, read, and shared in different contexts.
and for different purposes. Then we want to apply our approach of sharing by separation of concerns as a field example. This way, we aim to explain our approach and its application in real work environments.

*Carpart* is a large supplier of specialised car components for the automotive industry. We paid two visits to *Carpart*, one in November 2005 and the second one in March 2006, where we had the opportunity to learn to know a series of activities related to advanced engineering. During our first visit we mainly were able to observe how projects are managed. During our second visit we focussed on the process of innovation as well as interactions with suppliers. We observed co-located and distributed meetings, project meetings as well as design reviews and ongoing work at a series of workplaces in design, testing, and purchase.

The IMDS system in use in *Carpart* within the automotive industry in compliance with a EU directive is supposed to track chemical ingredients of parts and assemblies across the entire automotive OEM supply chain [4]. The following excerpt describes some of the difficulties involved in working with IMDS at *Carpart*. Figure 2 shows some of the main artefacts used in this case.

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A² checks her email. The first is a request from their office in D concerning IMDS calculations. A colleague needs details for different heating

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² A is a person working at *Carpart* in material definition and in material-related production.
wires. The email is about not finding the weight for all the wires and has an MS Excel sheet attached.

A has a file on her drive. She talks about having to copy the files all the time and sending them back and forth. She opens a table, noting down numbers on a post-it.

On her list there are two heating wires but the colleague in D looks for more. A sends him the ID for one of the wires and then tries to call the responsible for heating wires.

A explains: “No one is able to give us the right ID for some parts – the problem is that we deliver one part directly to the car producer and one to the seat producer and each has their own part ID – each supplier to LL has different numbers and at LL they don’t know which code we have”.

A then prints out the list sent by the colleague in D and goes to discuss it with an engineer next to her office. She returns with two new numbers to search for which she has jotted down in pencil. These numbers also don’t fit.

A explains: “This is our own list, the one the girl made for us, and it is already a little bit old”. A goes through the list manually. They don’t have anything on XX.

In another email she receives the data for the part SMART TCU-UN from their supplier. A looks at the data sheet – there are two part numbers, one for the front seat (21153) and one for the rear seat (211618), “when they buy it – when we sell it, we have to use the customer IDs for these parts, e.g., one for AA, one for FF”.

Now A needs to communicate the changes of part ID: she fills in a template with her name and the AA ID for the part and sends this to AA to see if they accept this ID. They do not accept.

A calls L who asked for this change, tries another ID: Maybe AA has forgotten to approve these numbers. She calls L again who promises to contact AA about this. A makes a note on the print-out of the email message so as to remember.

There are many unresolved issues around the IMDS database: suppliers, in particular small ones, have problems in providing detailed information about their parts. A has problems to retrieve this information. The different stakeholders use different part numbering systems and the mapping problems between these different numbering systems have not been resolved. This affects many workplaces at Carpart (among them testing, purchase, and sales). Furthermore, the Excel lists we saw are not continuously updated and again, mapping has not been resolved. The philosophy at the moment seems to be forcing the objective rather than support the process. A switches between her email, different lists, including print-outs of lists, her post-its, phone conversations, printing out lists, carrying them to another office to discuss the problem, and so forth.

In sum, the question here is how to access the part ID at the customer’s site or at all other sites which were involved in finding out what the real part ID
is, without accessing other confidential data about plants and materials. How is it possible to provide access to Carpart in the data repository of the customer or of other units of the same company? In the next section we illustrate the application of our approach in this case.

4 Separation of Concerns in the Case

In this section we want to show how our framework separation of concerns can be applied in our case. In Carpart there are several concerns mainly connected to products or production processes. These are related to the vendors or customers. To manage the concerns we need a meta-concern showing the relationships between different concerns. In case of A searching for part IDs of materials used in certain plants, we define the meta-concerns Materials, Vendors, Plants, Customers, InformationEntry, InformationUpdate, InformationRetrieval, and InformationRemoval (Figure 3). A selection of meta-concerns is shown in Listing 1.1).

Fig. 3: Some of the meta-concerns defined for our case at Carpart. All information related meta-concerns are related to the ones on the left side.

Listing 1.1: A part of metaConcerns.xml

```xml
<?xml version="1.0" encoding="utf-8"?>
<MetaConcern name="Materials">
    <Description>These are materials used in different parts.</Description>
    <Data>Link to the data repository where materials are managed.</Data>
    <Examples>Fibre, copper.</Examples>
    <Relationships>Plants</Relationships>
</MetaConcern>
<MetaConcern name="Plants">
    <Description>These are manufacturing plants and the complete equipment or apparatus for a particular mechanical process or operation.</Description>
    <Data>Link to the data repository where plants are managed.</Data>
    <Examples></Examples>
    <Relationships>Materials, Vendors, Customers</Relationships>
</MetaConcern>
<MetaConcern name="Customers">
    <Description>The customers of the company.</Description>
    <Data>Link to the data repository where customers are managed.</Data>
```
Concerns define their requirements for data access especially considering all possibilities of access by others than the organisation itself. Requirements determine the scope of relevant data for sharing. By the means of composition rules the concrete actions with constraints are defined in detail. The Listing 1.2 illustrates how relevant concerns and composition rules can be defined in our case of “retrieving or searching for the part ID of a plant”. In a shared environment with customers and vendors, access is provided only onto the part ID of a “Plant” and not to other data related to the definition and production of plants. All requirements to access data in case of information retrieval are defined in the concern of “InformationRetrieval”.

Listing 1.2: A part of the concerns.xml

```xml
<?xml version='1.0' encoding='utf-8'?><Concern name="Plant"
  <Requirement id="1">
    The part ID will be accessed.
  </Requirement>
</Concern>

<Concern name="InformationRetrieval"
  <Requirement id="1">
    It should be possible to retrieve information from the system.
    <Requirement id="1.1">
      It should be possible to access information about the material number.
    </Requirement>
    <Requirement id="1.2">
      It should be possible to access part ID of the plants.
    </Requirement>
  </Requirement>
  <Requirement id="2">
    It should be possible to obtain a list of materials with material number and part ID of the plants.
  </Requirement>
</Concern>
```

Finally, we need composition rules to define the relationships between concerns’ requirements at a fine granularity [6]. The Listing 1.3 illustrates how this can be done in our case: Information retrieval must be provided during all the Material requirements, requirement 1 of Plant, and all the InformationRetrieval requirements, including its children, with the outcome that the specified constraint is fulfilled. There are different constraint actions, like enforce, ensure, provide, applied, exclude, affect. For a detailed definition of the elements of composition specification see [6].

Listing 1.3: A part of the composition.xml

```xml
<?xml version='1.0' encoding='utf-8'?><Composition>
```
5 Conclusions

In this paper, we introduced a new framework to the problem of sharing and knowledge management across organisational boundaries. Our framework uses the concept of concern and compositions, based on the known approach of separation of concerns from computer science. We tried to illustrate how this framework can be applied in a real work setting.

It is astonishing that separation of concerns really offer a new way of thinking on the very complex problem of sharing among organisations. It is simple, plug able, extensible, and user-configurable. The acceptance of this framework depends on the tools that utilise the framework for stakeholders. This is what we plan to implement in the near future.

On the other hand, we could not really study and evaluate our approach in practice. In this version it is only a framework, i.e., a suggestion how the problem of sharing across companies can be approached and possibly solved. We plan to implement the framework in a cooperative work environment to find out whether the concerns and composition rules really trigger certain secure sharing actions without costing additional effort for the domain workers. Furthermore, we want to study the impact of crosscutting concerns onto other concerns, e.g., by evaluating possible technological solutions like logging.

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